13,092. "Improvements in electrolytic cells." J. RASCHEN and THE UNITED ALKALI COMPANY, LIMITED. July 4th.

over pulleys and wound in the reverse direction upon rollers, smaller than and rigidly attached to the first rollers. When, therefore, the globe is raised or lowered, the cords are simultaneously unwound from one of the rollers and

THE ELECTRICAL REVIEW.

VOL. XLIX. JULY 26, 1901. No. 1,235.

CONTENTS:

	PAGE
Standard Railway Traction	129
The Pascal Marino Accumulator (*illustrated*)	131
A New Electric Furnace (*illustrated*)	132
Parallel Running of Alternators	133
The Generation and Transmission of Electric Energy at and from Coal Pit Centres (*continued*)	134
Electrical Matters at the London County Council	136
Parliamentary Committees	137
The Mercadier Multiplex Telegraph (*illustrated*) (*continued*) ...	138
Correspondence:—	
Localisation of High Resistance Breaks	140
Purchase of Foreign Machinery	140
Refuse Destructors and Electric Generation	141
The Rasch Electric Light (*illustrated*)	141
Reviews	143
American Competition in English Trades	144
Business Notes	145
London United Tramways (*illustrated*) (*continued*)	149
City Notes	158
Traffic Receipts	160
Stocks and Shares	160
Share List of Electrical Companies	161
Market Quotations	162
The New Trunk Exchange No. 1 Berlin (*illustrated*)	163
Our Legal Query Column	164
The Electrical Resistance of the Human Body (*illustrated*) ...	164
The E.E.R.E.(V.) at Milford Haven	165
An Evaluation of Mathematics	165
Efficiency Test of an 125-H.P. Gas Engine	167
Smoky Furnaces, and How to Avoid Them.—I. (*illustrated*) ..	167
The Polyphase Induction Motor for General Power Service (*illustrated*)	169
Current Specifications.—LXXII.	170
New Patents	171
Abstracts of Published Specifications	171

THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

NOW READY.

H. ALABASTER, GATEHOUSE & CO.,

4, Ludgate Hill, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON, E.C.

Telegraphic Address: "AGEEKAY, LONDON." Code, A B C.

Telephone No. 933 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades,

AND HAS

BY FAR THE LARGEST CIRCULATION

of any Electrical Industrial Paper in Great Britain.

SUBSCRIPTION RATES.—In Great Britain, Post Free per Year, 19s. 6d. To all other countries, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. Paris: VEUVE J. BOYVEAU, 22, Rue de la Banque. Berlin: ASHER & Co., 13 Unter den Linden.

Cheques and Postal Orders (on Chief Office, London), to be made payable to Mr. H. ALABASTER, 4, Ludgate Hill, E.C.

STANDARD RAILWAY TRACTION.

WE do not often go out of our way to criticise a leading article in another electrical journal, but the ideas advanced in the editorial of an esteemed contemporary on July 12th seem to us so startlingly ill-advised that, in the interests of electric traction throughout Great Britain, and in the interests of the investing public whose opinion technical journals are expected to assist in forming, we are compelled to speak, and to speak strongly, against the views suggested by the article in question.

The effect of the Tramways Act of 1870, and the Light Railways Act of more recent date, show to those who have studied the subject how detrimental an influence unwise legislation can produce upon a growing industry. We do not mean to say that the Tramways Act of 1870 is entirely responsible for the fact that Great Britain to-day is behind all other civilised countries in the facilities locally provided for the travelling public, but certainly it is one of the principal underlying causes.

The leading article in our contemporary refers primarily to the deadlock existing at present between the Metropolitan Railway Company and the Metropolitan District Railway Company; it also assumes that in the future other companies will have difficulty in adopting a uniform system, and proposes as a solution that Parliament should choose a system, and then compel all companies to adopt it as the only standard.

As the article states, "one company insists upon one system—the other is equally determined to have another system." The sequence of events which has brought about this state of affairs is briefly as follows:—Three years ago the two companies agreed on the main principle that electric traction should be adopted; expert electrical engineers were called in, after which it was decided to equip an experimental line to prove that trains could be operated economically by electricity. £30,000 was voted by the two roads for that purpose.

The experiments having turned out satisfactorily, general specifications were issued permitting manufacturing firms and contractors to tender on any system they thought proper.

All the firms, with but one exception, are understood to have tendered on practically the same system so far as the type of line distribution is concerned, briefly described as *a third-rail 500-volt continuous-current system.*

One of the tendering companies advocated a three-phase alternating current distributing system with three-phase motors on the locomotives or locomotive cars, and a 3,000-volt overhead, two-wire trolley; the price quoted was considerably lower than that of any of the other tenders, and this naturally led to an investigation on the part of the engineers of the two companies, who reported favourably on the Ganz alternating current system as proposed, and recommended the acceptance of their tender. It is admitted by all concerned that up to the present time the system in

such as a battery. The arrangement of switches is described comprising a series-parallel controller of a usual type and reversing switches, and resistance and other switches which couple the motors and regulates the excitation and output. An automatic cut out voltmeter and ammeter are used in conjunction with the resistance switches to ensure that the voltage is sufficient. 10 claims.

Houston Company, Limited. (H. W. Buch.) Dated October 30th, 1899. Relates to means for minimising arcing in switches, cut-outs, &c. The terminals or points of contact are completely immersed in a body of glycerine or a non-carbonising hydro-carbon. The carbon should be embedded in a moisture-proof receptacle, or it should be covered with an oil or the like. 5 claims.

question, so far as regards its application to roads similar to the underground roads of London, is an experiment, and incidentally bears no resemblance to the apparatus employed in the experimental line equipped by the companies. The fact remains, however, that the engineers consider the tender of the Ganz Company to be the best of those submitted, and that the Metropolitan Company are prepared to follow their advice. In the meantime, the control of the Metropolitan District Railway has, to all intents and purposes, passed into the hands of a syndicate, and this syndicate has its own engineering staff, composed of men who have had a wide experience in electric traction matters where the problems met and solved were very similar to those requiring solution on the Inner Circle road of London.

These engineers, owing to their past experience, are able to figure with accuracy as to train schedule, cost of operation, maintenance, and probable gross receipts, and they have advocated the employment of a system with which they are familiar, and through which they are able to *guarantee* certain results. The syndicate supplying the funds for the proposed equipment, relying upon the opinion of their engineers, prefers to work on a sure basis rather than to attempt anything experimental, thereby excluding alternating current motors and 3,000-volt trolley wires. Hence the deadlock.

That the two roads, namely, the Metropolitan and the Metropolitan District, will operate on the same system ultimately is unquestioned, which is equivalent to saying that, by some means, the two companies *must be brought in accord*.

On the last day of the hearing of the Metropolitan District Railway Bill before the Parliamentary Committee, it was agreed that a referee be appointed who should hear the expert evidence for and against the two systems, and should then make a report to the Board of Trade, which would recommend the particular system to be adopted.

Whether both the railway companies would be bound to proceed in accordance with the decision of the Board of Trade is another matter, but such a decision would undoubtedly carry great weight.

The foregoing is an outline of the state of affairs at the present time, in so far as the general public are informed.

Now, assuming a decision of the Board of Trade to be strongly in favour of either of the two systems, how is it possible for Parliament at the present time to make a ruling which would for the future compel all railways of Great Britain which change over to electricity to adopt the system used on the Inner Circle? Parliamentary Committees are made up of able men, who carefully weigh evidence laid before them, but it would be necessary to have them endowed with more than human intelligence if they are to decide a question of this nature and magnitude on any evidence or opinions which could now be produced.

As the work of equipping suburban lines, branch railway lines, and perhaps even main lines of road progresses, changes in the existing system or systems may, and probably will, be found necessary. Very likely one system will not give the best results for all three kinds of service.

If Parliament should endeavour to choose a standard system, the first step would be to call in expert advice and, as we see the experts do, and probably would, disagree, Pending a decision, all progress in the direction of further equipping roads electrically would stop, to the inconvenience of the public, and incidentally the growth of a great industry would be checked.

Not long ago this nation was the leader among nations in all matters requiring initiative, energy, and business judgment—now if we judge from the article we are criticising we seem content to let other nations lead us while we petition Parliament to settle differences among ourselves.

Judged from both Constitutional and economic standpoints the suggestion of our contemporary seems more impossible still. Is Parliament to dictate how railway companies are to expend their surplus earnings or newly acquired capital? If so, why not equally guide our private companies, firms, and individuals, in their expenditures?

A uniform system would be preferable from every standpoint if that system incidentally were the best.

If we had to decide on a system for the Inner Circle, we could do so readily. If we had to equip 100 miles of any main line of railway, we should require considerable data, and then would retire to think. Perhaps we should require to think a second time, and we suggest a second thought to the editor of our estimable contemporary.

The Taff Vale Railway Case.

All those whose sympathies are with the employers in the great struggle between capital and labour, will have read the judgment of the House of Lords in the case of the Taff Vale Railway Company *v.* Amalgamated Society of Engineers with considerable interest. It will be recollected that the railway company sought an injunction to restrain the Amalgamated Society, or their secretary, Richard Bell, and their organising secretary, James Holmes, from watching or besetting, or causing to be watched or beset, the company's station at Cardiff or the works of the plaintiffs or any of them or the approaches thereto, or the places of residence of any workmen employed by or proposing to work for the plaintiffs, for the purpose of persuading or otherwise preventing persons from working for the plaintiffs, or for any purpose except merely to obtain or communicate information, and from procuring any persons who had entered into contracts with the plaintiffs to commit a breach of such contracts. Mr. Justice Farwell not only granted an injunction against Bell and Holmes, but also against the Amalgamated Society itself. His judgment as against the Amalgamated Society was reversed by the Court of Appeal, but the House of Lords on Monday last reversed the decision of the Appeal Court and restored that of Mr. Justice Farwell. Their reason for so doing is thus tersely expressed by the Lord Chancellor:—"If the Legislature has created a thing which can own property, which can employ servants, and which can inflict injury, it must be taken, I think, to have impliedly given the power to make it sueable in a Court of Law for injuries purposely done by its authority and procurement." Howsoever pleasing this momentous decision may be to employers, it is not likely to meet with much favour among the trade unions. The following is a copy of a resolution which was passed at the Congress when the unions were smarting under Mr. Justice Farwell's judgment:—"That in view of the statement made by Mr. Bell, and the very dangerous principle sought to be established against the trade societies of the country by the decision of Mr. Justice Farwell, this Congress hereby instructs the Parliamentary Committee to call the attention of the trade societies of the country to the above judgment, pointing out the absolute and urgent necessity of the case being fought right through to the House of Lords; and, seeing that this case equally affects every society in the country, that the Parliamentary Committee should obtain from each society their consent to a contribution *pro rata* for the purpose of prosecuting the appeal."

Cheques and Postal Orders (on Chief Office, London), to be made payable to Mr. H. Alabaster, 4, Ludgate Hill, E.C.

by all concerned that up to the present time the system in

D

THE PASCAL MARINO ACCUMULATOR.

By W. HIBBERT.

The influence of traction work on the design of accumulators promises to be very marked, especially in the reduction of weight, and in the prevention of distintegrating actions which cause the plates to come to pieces on the rougher roads.

In a recent design due to Pascal Marino, there is sufficient novelty to warrant a description. It is a lead accumulator, the active materials being peroxide and spongy lead as usual. But the plates are arranged horizontally and the acid employed is phosphoric, not sulphuric. Fig. 1 is a diagrammatic representation of the general arrangement.

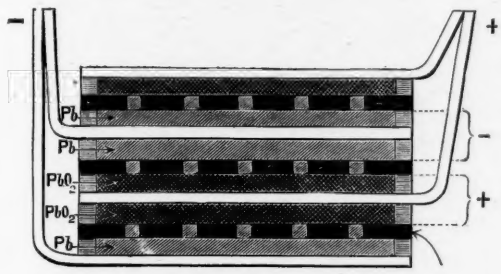


Fig. 1.

Each plate consists of a thin sheet of lead, flanked by a frame. Within this frame, both above and below, and in contact with the lead plate, is disposed the active material. Between one plate and the next is a separator, very porous, whose exact nature is not stated. Running vertically through the plates are one or more carbon chimneys for the purpose of carrying off gases. The details of this arrangement are not in the writer's possession, and could not therefore be put in the diagram. The plates having been built up in the compact way indicated, are immersed in dilute phosphoric acid.

It is stated that for the purpose of forming the active substances from the original materials, sulphuric acid is employed, but as soon as the formation is complete, the acid is changed, phosphoric acid being used in its place. The ordinary processes of charge and discharge are afterwards carried on in the phosphoric acid, but after each charge a few drops of a solution of hypophosphorus acid are added for the purpose of destroying any peroxides formed in the liquid.

The cell can, of course, be worked with sulphuric acid, but it is part of the theory of the inventor that the working electrolyte ought to be different from that used during formation. From one or two remarks in the official description, it would seem that the inventor has based his theory on a misleading analogy, but he is entitled to any benefit that may follow his practice.

The advantages claimed for this cell are, first, the very large proportion of active material. Thin lead plates are used, and a considerable thickness of active material can be employed without risk of the falling away which would ensue with a vertical plate. The horizontal arrangement gives good contact with the conducting lead plate, which is merely increased by any vertical expansions due to the electro-chemical changes. Lateral expansions are prevented by the ebonite frames. The separators, ebonite frames, and carbon chimneys are all very light.

Secondly, durability is claimed, arising in part from the compact form, and in part from the use of phosphoric acid. It is said that the tendency to local action (the great disintegrator with ordinary positives in sulphuric acid) is greatly diminished in phosphoric acid.

The failure of the horizontal arrangement in the past is attributed to two causes. First, the separators employed were not sufficiently permeable, and seriously increased the internal resistance. Secondly, proper provision was not made for carrying off the evolved gases. It is asserted that these difficulties have been overcome.

In respect to working tests, very little information is given. Two tests are quoted, but, strangely enough, sulphuric acid was used in both. The accompanying curves, fig. 2, show the fall of potential under the following conditions :—

A cell containing four plates, two positives and two negatives, 19 centimetres long, 12 centimetres broad, 4 centimetres deep, and weighing 2 kilogrammes (4·4 lbs.) was charged at 145 amperes for 1 minute.

Curve A is the voltage fall, while the discharge current fell from 5·4 to 5·0 amperes in 21 minutes.

The cell was now charged with 150 amperes for 1 minute and a similar discharge curve obtained, the current falling to 5 amperes in 23 minutes.

Charged again at 175 amperes for 1 minute, curve B was obtained, the current falling 5·4 to 5·0 amperes in 32 minutes.

These tests were apparently directed solely to prove the possibility of a high charging rate. No statement is made of the previous history, and as these figures were obtained with sulphuric acid, we are left in ignorance as to the behaviour

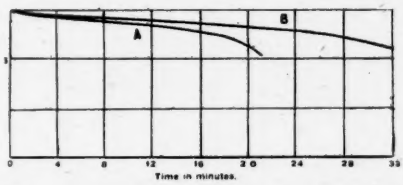


Fig. 2.—Current fell from 5·4 to 5·0 Amperes.

with phosphoric acid. It is obvious that the people responsible for these tests have no idea of what is required in the way of evidence. Tests of capacity and of efficiency at various discharge rates, and finally of life under workshop and travelling conditions, are all ignored.

The cell is an interesting variation from the ordinary. It may be doubted, however, whether the substances will be quite free from local action. In all probability the thin lead plate will be eaten into, though more slowly than if sulphuric acid were employed. But with the horizontal arrangement this will not lead to disintegration; the peroxide formed by local action will be added to that already there, and be kept in position by the superincumbent mass. So far the cell will be all right, provided that the disturbing gases are properly led away by the chimneys. The weak point will probably appear in or near the line of junction between the lead lug and the sheet to which it is attached. Experience only can determine how long this or other possible defects will take to develop. It ought to be clearly understood by those who offer accumulators to the public that more definite tests are required before a fair judgment can be formed.

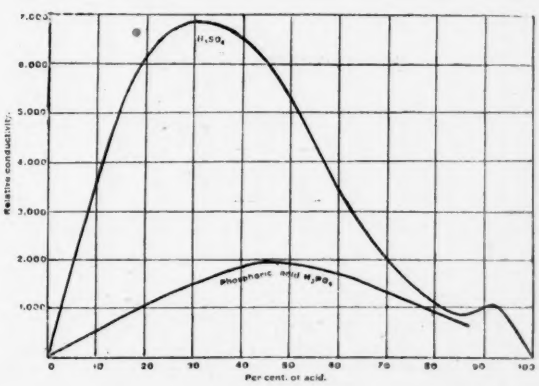


Fig. 3.

There are several important considerations raised by the cell, about which no information is given. It is probable that very few have had any experience with phosphoric acid, and it may be helpful if I give some data of my own experience. So far as I know no observations of the kind have yet been published.

Conductivity.—Phosphoric acid has a relatively low conductivity; its maximum is less than one-third that of sulphuric acid. The accompanying curves show this; the

maximum for sulphuric acid is found at 30 per cent., whereas with phosphoric acid it is about 45 per cent. The data are from Kohlrausch.

Electromotive Force.—The E.M.F. varies with the strength of the phosphoric acid, but is always lower than the value obtained with sulphuric acid. The following values were obtained :—

E.M.F. between PbO_2 and Pb in Phosphoric Acid.

Density.	Per cent. H_3PO_4.	E.M.F.
1·052	9·66	1·69 volts.
1·080	14·3	1·72 ,,
1·252	40·0	1·77 ,,
1·325	49·7	1·81 ,,
1·500	69·0	1·86 ,,

The observations are only approximately correct. Phosphoric acid is a much more viscous liquid than the corresponding sulphuric, consequently, diffusion was very slow, and it was not easy to say when the acid in the pores of the plates had become equal to that outside. For the same change in strength of sulphuric acid, the E.M.F. would rise from 1·94 to 2·31 volts.

While charging, the potential difference was about 2·6 to 2·65. On stopping the charging current, there was an abnormally high E.M.F. for a little while, just as is the case with the ordinary sulphuric acid accumulator. If we adopt the theory of this transient E.M.F. advanced by Dr. Gladstone and the writer for the case of the Planté cell, we must suppose that during charge the acid in the pores of the anode or positive is enriched, and so exalts the E.M.F. in accordance with the table already given. The following curve (fig. 4) indicates the fall of E.M.F. on open circuit immediately after charging is stopped. The fall is here due to diffusion of

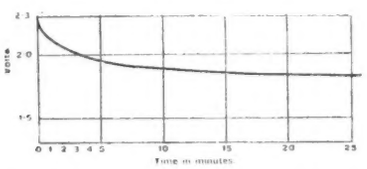


Fig. 4.—E.M.F. after Charging Current ceased.

strong acid from the pores of the positive, where it has been accumulating during charge, owing the electrolytic carrying of PO_4 to that plate.

A NEW ELECTRIC FURNACE.

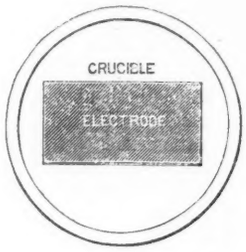
[communicated.]

Since the time when calcium carbide was first manufactured as a commercial product, continual efforts have been made to reduce the cost of production. Calcium carbide, being a true chemical compound, the proportion of calcium and carbon in it must in all cases be constant, so that, with the exception of procuring purer lime and coke, no saving could be effected in the materials of which it is composed. The points to which it was then necessary to direct attention in order to obtain a lower prime cost were four, viz. :—

1. Greater efficiency in the prime mover and generator.
2. A reduction in the cost of labour.
3. Higher efficiency in the furnace.
4. The manufacture of carbide with a less amount of crust.

When carbide is made, especially on the ingot system, the outer layers are not properly fused, and the output of gas from these layers is considerably less than what it is from the core of the ingot, and either this crust has to be thrown away, and so represents so much loss, or else it is broken up and mixed with the rest, and consequently lowers, to a great extent, the volume of gas given off per pound of the commercial carbide.

During the course of last autumn Mr. A. Parker, of Chorley, was appointed manager of some carbide works, where the motive power was derived from water. He soon appreciated the fact that if the business was to be a financial success, owing to the fall in prices, the old methods would not be enough, and that great economies in the working must be introduced. It was evident that only a limited amount of saving could be effected in obtaining a greater efficiency in the prime mover and the generator. The latter was a modern dynamo specially built for furnace work, and it was not considered possible to improve upon this. The water-power was cheap ; but, on the other hand, it was not utilised to the best advantage. Much of the water was allowed to escape, and a far greater head was available ; in addition, the latent power in the stream was turned into mechanical energy by means of an old-fashioned out-of-date water-wheel. Mr. Parker found, as he had anticipated, that even when the water-wheel had been replaced by a modern high-speed turbine and all the cumbrous heavy gearing taken out, although a large advance had been made in the power available, the method of working must be still further cheapened if the factory was to compete successfully with other and larger works. In passing, it might be mentioned



that one great advantage had been gained. In nearly all electric furnaces the arc is frequently broken and the load is suddenly thrown off the machine ; with the old water-wheel there was no means of regulating the speed, and the dynamo immediately commenced to race ; the new turbine was fitted with sensitive governors, and so an approximately constant speed was maintained under any load ; in addition, the turbine could be stopped by means of an electric stop motion from either the dynamo house or the furnace room.

Finding that still greater economies must be effected, Mr. Parker next turned his attention to the other points where it has been noted that a reduction in the cost of manufacture was possible. His primary idea was to reduce the labour required, by adopting simpler arrangements and automatic machinery as far as possible ; and also to devise some method of preventing to so large an extent the formation of so thick a crust of improperly fused carbide. He commenced various experiments, and finally took out a patent for a new furnace, which appears to have solved many of the difficulties under which carbide has heretofore been made.

The furnace consists essentially of a circular revolving crucible lined with carbon and an elongated carbon as the positive electrode. The diagram shows the relative proportions of the two. The crucible is fed by means of two hoppers fixed, though not in connection with it, at either side of the positive electrode. The feed is automatically arranged at a very slow speed, and as the crucible revolves at a carefully-arranged rate in accordance with the current available, and the feed, which is also dependant upon the current, the powdered mass is immediately conveyed, in thin layers as it were, under the action of the electrode and at once obtains a molten condition. It is evident that since the hoppers are stationary and the crucible revolves, the powder is spread out equally all over the bottom of the crucible, and with the carbon being also stationary, each layer of the coke and lime receives the full effect of the current, it will be seen from the diagram that the corners of the electrode are within measurable distance of the crucible sides, and so there will be no appreciable portion of the mass,

or crust, which is not thoroughly melted. There is no question that this arrangement is a great advance upon the old methods, where the electrodes are too often either buried in a mass of the material to be melted, or else rigidly fixed as regards the crucible, so that one part receives a large excess of the available heat, and another part, the crust, receives less than its due share.

In the course of experiments which were made with this form of furnace, it was found that the crucible filled faster than the electrode burnt away, so the patentee further protected a device consisting of a suitable train of gearing, by which the electrode is automatically raised the whole time the furnace, is working, so that the length of arc may always be kept constant. One of the faults of many types of furnaces is the breaking of the arc due to the falling away of the mass from the electrodes, with this automatic raising of the electrode during working this liability of a broken arc is greatly reduced; in fact, with a small experimental furnace the arc was not broken once during a run of 36 hours, and the inventor is convinced that in practice the furnace will run for a week or more, unless it might be necessary to renew the carbon electrode. The time occupied in removing a full crucible and putting in an empty one, adjusting the arc, &c., is less than three minutes, from cutting of the current to having it on again. In the completed furnace, arrangements have been made for letting in pieces of dark glass in the enclosing brickwork; which is another advantage, as carbide making, like most other operations, can be done better when it is easy to see what is going on.

Mr. Parker has applied for patent rights in America as well as in England and on the Continent, and arrangements are in progress for selling the sole interests in these patents to his firm, and if the negotiations come to a successful issue they will be the owners of a very valuable asset, since the capabilities of the furnace are not confined to the production of calcium carbide, but may be extended for any other metallurgical work. The writer has been consulted many times whilst the experiments were being made, and from his practical knowledge of what has been accomplished he is satisfied that the furnace will effect considerable economies in the labour required, and the amount of inferior crust formed; he also thinks that a much higher degree of efficiency will be attained; that is, a larger output will be obtained per kilowatt-hour, than is the case with any existing furnace. This point, however, can only be definitely stated, when the furnace has been tried for some time in actual work.

At a later period the writer hopes to be able to contribute a further article giving figures of the output obtained per kilowatt-hour with various loads, and also to publish photographs of the furnace, and fuller particulars. These particulars will also deal with a new feature which Mr. Parker has introduced since the writer saw the furnace last, by which the furnace can be used as a tapping furnace, and the molten carbide can be cast into blocks, strips or any other desired form.

PARALLEL RUNNING OF ALTERNATORS.

[COMMUNICATED.]

The subject of engine design for this purpose is one of much interest, and the writer ventures to bring forward a few points in the hope that others may give their views.

The specification usually contains two clauses as follows:

Cyclic Irregularity.—Not to exceed $\frac{n}{360}$ths of the pole pitch arc, *i.e.*, a point on the rotating wheel must never be more than that fraction ahead or behind the position it would occupy if the wheel were rotating uniformly. This clause sometimes takes the form:—"The variation of angular velocity at constant load is not to exceed n per cent. For reasons stated below the first form is to be preferred.

Change of Steady Speed.—The steady speed shall not vary more than n per cent. above and below the normal with a change of load.

Roughly, the conditions affecting these variations are:—

1. Fluctuation of crank effort.
2. Inertia of rotating parts.
3. Number of cranks.
4. Sensitiveness of the governor.

The cyclic irregularity is proportional to the fluctuation of crank effort and to the frequency of that fluctuation. It is inversely proportional to the moment of inertia of the rotating parts and is not affected by the governor.

Suppose the governor is made sensitive enough to prevent a change of speed, not exceeding that specified, with a given change of load, and that the fly-wheel is made heavy enough to keep the cyclic irregularity within the limit specified, we may yet have an unsuitable engine, one which will hunt slowly.

With a single crank engine the fly-wheel will be in front of, and behind, a steadily turning wheel twice in each revolution, and if the fly-wheel is designed to allow not more than the variation of angular velocity specified, there may yet be a considerable relative angular displacement of the two wheels, because the swinging takes place continuously in the same direction for a quarter of a revolution. With two cranks at right angles this swinging occurs four times in the revolution, so that with a fly-wheel designed to allow the same fluctuation of *angular velocity* the maximum phase difference will be one-half of that above, or with the same fly-wheel the maximum difference will be only one quarter. That is with the same fly-wheel and one, two and three cranks, the maximum share differences will be in the ratio $1 : \frac{1}{4} : \frac{1}{9}$.

This is not true unless each fluctuation of crank effort in a revolution is the same, a condition which is not satisfied for all loads, when, as is usual, governing takes place on the H.P. cylinder only. It is clear, however, that with an increase of the number of cranks, the frequency of the cyclic irregularity is increased, and a much lighter fly-wheel may be used.

But the governor only comes into action twice in a revolution, and there are objections to governing on more than one cylinder (excessive receiver space, &c.), so that with a four-crank engine the fact that it takes two revolutions for one feed of steam to pass through the engine outweighs the advantage of the smaller cyclic irregularity. Suppose the load is lessened just after steam is cut off in the H.P. cylinder, that feed of steam will do more work than is required, and the speed will be increased; the next feed of steam will, therefore, be too little, and the next, so that a slow swinging action is set up, and this slow swinging is more harmful than the rapid cyclic irregularity. If, however the load remain constant this swinging will die out, but in first paralleling the load does not remain constant and this action may, and does, prevent paralleling.

With a two-crank engine this effect is less; with a single crank still less, but the best arrangement from this point of view would be a six-cylinder compound working three cranks at 120° and governing on each H.P. cylinder.

As regards the governor, when there is a large variation of angular velocity in the revolution, the point at which the governor acts becomes important; as this variation can be pre-determined it should be so arranged that the variation which occurs about the point of cut-off is less than the others; if possible the governor should act just as the angular velocity is at its mean. The governor should not respond to variations of angular velocity such as occur in each revolution; much trouble is caused by making the governor too sensitive. The more sensitive the governor the greater effect does friction have and the more likely is it to hunt. Nowadays few designers err in making the governor of insufficient power, so that the hunting due to friction is only of importance when the governor is over sensitive.

It seems, then, that the single-crank engine is less likely to indulge in slow "swinging," and in that respect is more satisfactory than a triple-expansion with three cranks; but it will have a greater cyclic irregularity and will need a heavier fly-wheel.

Generally, my conclusions are that the most suitable engine would have two or three cranks with two cylinders on each crank, governing on the H.P. cylinders. The fluctuation of crank effort would be made as small as possible in the region

where cut-off takes place. The cyclic irregularity, specified in the form first indicated, would be met by a fly-wheel of moderate weight. The speed would be high, so as to reduce the number of poles for a given frequency, and keep down the mass of the rotating parts.

The governor is only sensitive enough to respond to changes of speed greater than those occurring cyclically in each revolution.

THE GENERATION AND TRANSMISSION OF ELECTRIC ENERGY AT AND FROM COAL PIT CENTRES.

By B. H. THWAITE, C.E.

(*Continued from page* 20.)

Commercial Considerations.

The commercial advantages to the power user, have already been set forth in the author's 1892 paper. It may be said, however, that unless a factory owner is very exceptionally located, it will be to his considerable advantage to obtain his power supply from the electric power service. Even at distances of over 100 miles from the generating station it will be possible (if sufficient patronage is accorded to the power source that will permit 75 per cent. of the full capacity of the line to be transmitted constantly through it) to provide a power energy for £7 per 8,000-hour year of 1 E.H.P. An authority has stated that 10,000 KW., transmitted 500 miles at a line pressure of 40,000 volts and a line efficiency of 50 per cent., would cost approximately £9 per E.H.P.-year delivered *(always assuming a satisfactory load factor)*; the price stated would allow for a fair rate of depreciation, and includes 4 per cent. for interest in addition; by increasing the line efficiency to 75 per cent. the cost on a similar basis would be only £8 7s. per E.H.P.-year.

Given that the demand for power is well sustained, and equal to the capacity of the transmission line, there should be no commercial difficulty in providing electrical lighting stations with power at 3½d. per kilowatt-hour, and to power consumers at *less than* one-third of this figure. Any system that does not permit the supply of bulk energy at these rates is not likely to prove a commercial success, because in considering the commercial features of a bulk supply installation, *the fluctuations of trade should be recognised*. Cycles of trade and industrial depression will always occur, due to various causes, such as war and political episodes, and the demand for electrical power will shrink, so that the conditions are drastically different from either tram-car, lighting, or other merely local applications.

The concentration of our great staple industries in specific areas, and the geographic compactness of our country, along with the fact that nearly all our large manufacturing industrial areas have associated coalfields, constitute qualifications that invite, with extraordinary appropriateness, the bulk distribution of cheap electrical energy for producing power and light, as well as for the service of electrical processes of industry. The abundant supply of cheap electrical energy distributed all over our industrial areas should, and will probably, stimulate our manufacturers to adopt the most progressive methods and apparatus; it will certainly widen the field for the profitable employment of capital, and especially in the electrical processes that depend for their *raison d'être* on the bulk, cheap, and continuous supply of electric energy. The grand consummation will perhaps be the restoration of the industrial activity of our country. The cheapest power energy, coupled with the unrivalled mineralogical advantages of our country, and the displacement of the locomotive by the electrically and directly axle-propelled large-capacity hopper wagons, will enable our manufacturers (if the railway companies will only bring down their freight rates to the level of those in Germany) to deliver their manufactured goods to the vessels of our still unrivalled mercantile marine at prices that should still defy fair and unsubsidised foreign competition.

The fact that electrical energy can be economically transmitted, radially, from any coalfield generating centre for a distance of 100 miles, means for our country, owing to its remarkable geographical compactness, the possible supply of electrical energy at a figure that no country, other than that possessing the natural power resources of waterfalls, can ever hope to obtain. This economic power advantage in fighting industrial foreign competition, by the carrying out of well-devised coalfield electrical transmission projects, may make all the difference between failure and success. When the coalfield transmission projects are completed, Faraday will be found to have bequeathed to the country he loved so well, a national gift of incalculable value.

APPENDIX.

Introduction.

Some Remarks on the Machinery of Power Transmission, &c.—The nine years that have elapsed since the publication of the particulars of the original coalfield electrical power transmission project, have produced a crop of data and results from actual experience, and the garnered harvest of this crop constitutes all that is required, if properly utilised—to obtain economically satisfactory results in the long-distance transmission of electrical power, and its commercial distribution.

It is very fortunate that in the beginning of the new century we are able more or less implicitly to rely upon the various agents required in electric transmission work, and to know that their degree of efficiency within the control of the engineer leaves comparatively little margin for improvement.

A few descriptive references relating to the various agents and the *modus operandi* that may be adopted in order to avoid mistakes, and also secure high efficiency, may not be out of place. Only methods and apparatus that have been put to test are referred to.

The Generating Machines.

Preliminary Considerations.—Choice of Phase.—It has been sufficiently shown that the analysis of successful applications demonstrated by the law of the survival of the fittest, has determined that in the choice of phase there need be no difficulty in deciding in favour of the three-phase.

The author has analysed the character of power transmission installation carried out in the last eight years by one famous Continental firm, the ratio of popularity proved by this application, is approximately expressed as follows:—Mono-phase, 10; bi-phase, 100; tri-phase, 300.

Frequency.—Experience points towards a range of frequency between 50 and 60 as the most serviceable. In America, it is stated that the decision to adopt the low frequency of 25 for the Niagara power transmission installation, was a regrettable one.

On the other hand in the electric applications of the early "nineties," frequencies were twice as high as the average of modern practice, this high rate of early frequency, of 120, and still higher, has only one advantage, *e.g.*, the slightly lessened cost of transformation, but the inductive troubles were serious.

The best practice includes frequencies within the range of 50 and 60, although, with transformers of the rotary type, the lower rate of 35 has, in some instances, been adopted.

For local distribution, the lighting consumption of electric energy reduces the range of the limit of suitable frequencies. The frequency may be kept with advantage below 30. For alternating arc lighting the frequency should not be allowed to fall below 40.

The marked division of opinion between the advocates of the continuous and the alternating current systems, so conspicuous in the early "nineties," has, to a considerable degree, disappeared. Judging from the analysis of successful results of long-distance electric transmission installations, there is only one conclusion to be drawn, and that is, the undoubted supremacy of the alternator.

The enormous power capacities of alternator machines that can be secured, not limited even to 5,000 KW. per machine, the economy in weight of copper per unit of power capacity, and the remarkable convenience of the alternating system, are all features of the first importance.

The triphase will permit the application of over-loads

better than either of the other two phases, and the structural weight of a three-phase generator is less for a given output capacity. The biphase has not secured any considerable patronage because its power factor is low, and the starting of the motors is usually effected *only at no-load*; this latter feature obviously constitutes a very considerable disadvantage.

There is no difficulty in obtaining a steady output from well-designed and accurately-proportioned three-phase alternator machines. Even with a variation per revolution, corresponding to one-eighth of the polar division, a very regular output is obtainable.

Strangely enough, the same characteristic defects, although not in a similar degree, exist both in the three-phase alternators and in the gas motor; in both the best efficiency is obtained in working them at their fullest capacities. A reduction of this maximum output very seriously reduces the effective working efficiency, and it is better in both instances to have some of the machines of graduated sizes, in order that a fall in the demand can be met by cutting off the generating units corresponding to this fall and maintaining the balance, working *at their fullest capacity*, and always, of course, in parallel. This principle was adopted in the author's 1892 scheme. By establishing a constant maximum potential of the generators in action, erratic variations of output will also be prevented.

So far, the voltage of the generating units has generally been kept within the maximum limits of 4,000 to 5,000 volts, and the transformer raises the pressure to the degree required to effect economical transmission; 12,000 volts pressure is considered the highest practicable voltage desirable for the generating machine. There is a decided tendency in favour of increasing the voltage of the generators *per se*, and the early part of this new century will very probably be witness to outputs from the generator terminals of such pressures as will make pressure-raising transformers quite unnecessary — instance the Wiesloch installation already described. Alternating generators with stationary armatures to supply energy at 10,000 volts have already been built, and the transformer capacity reduction resulting from this high initial voltage has been equivalent to a *lessened* loss of 2½ per cent.

When it is decided to employ raising pressure transformers, it is advisable for safety reasons to keep down the voltage of the generators to 1,000 volts.

Electric generators of even 5,000-volt pressure should be *exceptionally* well insulated from their foundations, and if direct-coupled, and if the electric generator constitutes the *fly-wheel* of the gas or steam engine, the couplings should be insulated *very carefully* indeed.

When several generators make up the output capacity of an electric power station, they should obviously be arranged to act in parallel or in synchronous sympathy; and the structural character of their armatures, whether core or iron-clad, should exactly correspond.

It is far easier to synchronously combine in parallel harness generators having a high factor of inductance, than those having a non-inductance factor.

Control of Output.—The use of phase lamps to determine the speed and phasic conditions is perhaps sufficiently exact for every-day commercial work. It is easy to cut in additional machines, because the exact pendulum swing corresponding to a given frequency is readily caught.

An electric generator, designed to satisfy the exigent demands of light and power supply customers, should have, as a primary qualification, a thoroughly satisfactory degree of regulation, and for the service specified, the reactions of the armature should be reduced to a minimum.

The armature reactions have been reduced in modern generating alternator machines by the application of compounding, and this principle has permitted a close approximation to a fairly constant potential to be obtained on non-induction loads. It may be noted that claims have been made in favour of high inductions of large armature reaction generators, because of their lessened danger of being burnt out, but the claims are only fairly applicable to badly-designed armatures.

An ideal electric generating equipment for long-distance transmission work should be designed to give perfect regulation of voltage of the energy it generates.

The effects of inductance and armature reaction should as far as possible be eliminated.; alternators that require a large increase in the existing ampere-turns to hold them fast to normal pressures or voltage under full load, should be condemned, because of the fact that their effective E.M.F. falls off under this full load very seriously.

The line inductance effects should always receive the greatest consideration; only the most careful regulation of the intensity of excitation, will permit the maintenance of a reasonably uniform voltage. The effect of the inductance of the line involving the addition of a few per cents to the voltage potential should not be overlooked.

The ideal generator should have an ontput capacity over the maximum required to satisfy the service line demands, and its intrinsic regulation should be as perfect as possible.

According to Mr. Louis Bell, "A generator capable of holding its voltage from no load to a full and inductance load, with an increase of only 15 per cent. or 20 per cent. in the exciting current, will usually give no trouble whatever." A well designed and built generator will be capable of self-adjustment to satisfactorily compensate for the effects of load removal, or when the current wave is distorted by an induction load. The fly-wheel type of alternator, with stationary armature, is becoming decidedly popular.

Again we have another link that most appropriately couples the ideal three-phase alternator electric generator, with the ideal thermo-dynamic or internal combustion engine. The Otto cycle of alternative effective and non-effective piston reciprocations requires, as a necessity for steady running, the establishment of a large potential of energy in motion, such as is the rim of a heavy fly-wheel when revolving; but the constant turning of this heavy mass involves a not altogether inconsiderable loss of dynamic energy. By the displacement of this fly-wheel by an alternator electric generator, this non-effective dynamic energy absorption (measured as externally effective or saleable power) is very greatly reduced.

The structural cost of the triphase alternator for a given output capacity is intrinsically less than that for a biphase machine. Of course, the difference varies according to the design and the reputation of the maker. One comparison made by a press organ devoted to the electrical industry gives the cost of triphase alternator of a given output as equal to £5 4s. per kilowatt, and that for the biphase as equal to £7 per kilowatt.

Relation Between Generator and Motor.—The more intense the field, the less the armature inductances, and reactions of both generator and motor, the higher the magnitude of the alternator outputs actually obtainable, and this without overloading the motor and eventually disturbing the harmony of the mutual rotary action, between the generator and the motor.

As it is necessary, in alternating machinery, for the generator to be separately excited with a constant current machine, it is possible to maintain the field intensity in a condition of comparatively perfect constancy.

Current Reorganisers.—The introduction of alternator machines for long-distance transmission work has involved for many applications the transformation of the current from alternating to continuous.

When the consumer requires the energy for electro-welding, cauterising, and electro-fusion purposes, the alternating current needs no transformers; but for electrolytic operations, as well as for arc and incandescent lighting and for traction purposes, the continuous current is for the former purpose considered advisably necessary until more perfect regulation is obtainable, and for the latter purposes, and in many applications it is advisable.

The law of the survival of the fittest rapidly defines the most economic and efficient systems for various industrial purposes. The rotary transformer system involves the actuation of a single shaft that passes through the armatures of an alternator motor and continuous generator; the rotation of the latter is effected by the motion of the former, and the transformation is thus effected with the minimum loss in energy transmission. This loss in well-constructed machines should not exceed 5 per cent. This direct coupled

arrangement is vastly superior to the belt-driven one. The most efficient transformer load is that equivalent to 85 per cent. of the maximum output capacity, and this is obtained with the Schuckert type of machine.

Messrs. Schuckert have made striking progress in the perfection of rotary transformers, and their latest machines leave little margin for improvement. The Schuckert improved machine consists of a motor-generator with double field and armature; it not only provides very high efficiency, but a very close regulation of output is also obtained.

Practical electrical investigators and experimentalists are attempting to apply the alternating system to purposes for which the continuous current system has hitherto been considered the best.

(*To be continued.*)

ELECTRICAL MATTERS AT THE LONDON COUNTY COUNCIL.

THE Council at the meeting on Tuesday had under consideration various applications for loans for electric lighting purposes. It was decided to sanction or advance the following:—Hackney Borough Council, £8,000 for the purchase of a site for an electric lighting station and refuse destructor, and £34,200 for building works in connection with them; Woolwich Council, £20,000 in respect of buildings for the electric lighting station; Hampstead Council, £9,623 for engineering works and electric light meters; Islington Council, £2,500 for extension of mains and £2,018 for the purchase of meters; and the Woolwich Council £27,805 for electric lighting, street lighting and purchase of meters.

Life of Electricity Meters.—The Finance Committee reported that the Hammersmith Borough Council had applied for a loan of £1,903, repayable on the instalment system within 42 years, for the purchase of electric light meters. The Committee were advised that the Council could legally sanction the borrowing for that purpose, but that meters could not be considered to be part of the initial installation of the electric light, and that, therefore, the period for repayment of loans for the purchase of meters should be limited to the estimated life of the meters, which might be fairly taken at 10 years. On the recommendation of the Committee the Council resolved to grant a loan of £1,900 on this condition. The principle of 10 years thus established was also made to apply to all the before-mentioned loans where the purchase of meters is proposed.

The Tramway Power Station.—The adjourned report of the Highways Committee recommended the Council to apply to Parliament in the next session for powers to compulsorily acquire certain property adjoining the Greenwich tramways depôt for the purpose, including the depôt, of a site for the erection of a generating station for the operation of the tramways in South London. The reasons for substituting the Greenwich for the Camberwell depôt were stated in the last issue of this journal, and the committee's recommendation was now adopted without discussion.

Shallow Underground Tramways—The report of the Highways Committee reminded the Council of the instruction given to the Committee in June, 1899, to investigate and report on the practicability of constructing a shallow underground electric tramway from Westminster *viâ* Parliament Street, the Strand, Fleet Street and Cheapside to the Bank, and thence under Moorgate Street to the tramway terminus at Finsbury Pavement. The instruction further suggested the consideration of the question from the standpoint of the principle adopted in the case of the lines constructed under Andrassy Strasse, Buda-Pesth, and in Boston, U.S.A., and the inclusion of provision for subways to contain gas and water mains, electric light cables and telephone conductors. It was now stated by the Committee that careful consideration was being given to the question, and that valuable reports had been received from the Council's officers on the subject. Since the date of the instruction, however, the Council had engaged the services of an electrical engineer, and as the development of such schemes was largely carried on in America, it had occurred to the Committee that it would be advisable if he and the tramways manager were to visit that continent for the purpose of observing in what way such projects had been carried out, and to report whether similar schemes could with advantage be proceeded with in London. Whilst that should be the primary object of the visit, the officials would, no doubt, be able to obtain information which would prove valuable in regard to the latest developments of electrical and other forms of mechanical traction in that country. Both the officials would be willing to use the annual holiday of four weeks for the purpose, and in order that they might be able to make a thorough investigation, the Committee thought the holiday should be extended from four to six weeks and that their travelling and other expenses should be paid by the Council. A recommendation to this effect, voting £250 for the expenses, was adopted without discussion.

The Lewisham and Penge Provisional Orders.—The Highways Committee reported last February that the Lewisham and District Electric Supply Company had applied for a provisional order in respect of the Borough of Lewisham within the county and of the parish of Penge outside the County of London. It was then decided by the County Council to suggest to the Board of Trade that that part of the area within the county, and which was covered to a large extent by the order granted to the Lewisham District Board, should be omitted from the company's order. The Committee now stated that the Board of Trade had decided to grant two orders, for Lewisham and Penge respectively. These orders had been scheduled to one confirmation Bill, in which a provision had been inserted with the concurrence of the Borough Council, repealing the Lewisham District Order, 1899. The parts of Lewisham and Penge already covered by the Blackheath and Greenwich and the Crystal Palace District orders had been excluded from the areas under the orders now granted. The report of the Committee proceeded to state that under the orders in the form in which they were forwarded by the Board of Trade to the Council for its observations, the Lewisham and District Electric Supply Company, to which the orders are granted, will, after the passing of the Confirmation Bill, be enabled to supply electricity in a portion of Penge, which is outside the County of London, and in a portion of Lewisham, which is within the county.

It will therefore be possible for the company to place its electricity generating station outside London, and to give what may be described as a "bulk" supply to the area within the county under the Lewisham order; or if, on the other hand, the generating station should be placed within the county, the local authority, should it decide to purchase the undertaking within its area, might be saddled with a possible liability to supply energy in the area outside the County of London, under the Penge order. The Lewisham order contains a clause prohibiting its supply of energy beyond the area under the order; and a clause to a similar effect in the Electric Lighting (Clauses) Act, 1899, is incorporated in the Penge order. In both cases, however, the prohibition is qualified by the use of the words "otherwise than under the authority of Parliament or under a license granted by the Board of Trade under the principal Act." The undertakers will thus have power to supply energy in both Lewisham and Penge; but it seems doubtful whether the local authorities would have power, after acquisition of the portions of the undertaking within their respective districts, to supply energy outside their own districts. The undertakers may, for the purposes of either of the orders, erect or lay down electric lines and works beyond the area of supply without apparently the authority of Parliament or license from the Board of Trade. It would seem, therefore, that the undertakers could erect a generating station either in the Penge area or in the Lewisham area, or outside both those districts, for the purpose of supplying under both the orders. It seemed, therefore, not unlikely that when the time shall arrive for the purchase of the undertaking, either under the Electric Lighting Act of 1888 or under the special clauses contained in the orders, difficulties might arise owing to the local authorities being able to purchase the mains, but not the generating station. These difficulties might perhaps, although it does not appear clear that they would, be met by provisions of the Act of 1888 and the special purchase clause enabling the Board of Trade to determine any question which arises with reference to the purchase which is not to be settled by arbitration.

The attention of the Board of Trade was drawn to these points with a view to the insertion in the orders of any clause or clauses to meet them. In reply the Board of Trade suggested that the same difficulties would arise whenever a company was supplying energy from one station for use in the areas of more than one local authority, and at the same time pointed out that the question of the generation of electricity was not dealt with in the orders. In the circumstances the Board expressed the opinion that the question raised should be determined under the provisions of the special clause inserted in the orders, and that it did not see its way to suggest the insertion of any further provision. In view of this decision the Highways Committee stated that they did not consider that any further steps should be taken in the matter.

Lighting of Eltham.—It was announced by the Highway Committee that two notices had been received from the Blackheath and Greenwich District Electric Light Company of intention to lay high and low tension mains in parts of Eltham. The Woolwich Borough Council, whose views on the proposed works had been invited, stated that it strongly objected to the company laying any further mains or doing any further work in Eltham. The ground for the objection was based upon the fact that on June 11th last the Woolwich Council gave the company notice under the terms of Clause 65 of its order of 1897, requiring the company to sell so much of its undertaking and works as are situated in Eltham, which forms part of the Borough of Woolwich. The clause in question, known as the "Camberwell clause," which is contained in both of the company's orders, provides that the company's works may at any time before the expiration of the usual period of 42 years, be purchased by the local authority on payment of £133 for every £100 properly expended by the undertakers. Twelve months' notice of purchase has to be given under this clause, and the expenditure of the company upon which the purchase price is reckoned extends to the end of the period of notice. The Woolwich Borough Council, in its communication on the subject, alleges, in effect, that the company, having received notice of purchase under the special purchase section, is proceeding to incur large expenditure on capital account which, in the opinion of the Borough Council, is not justified, and would not be incurred by the company but for the prospect of receiving it back shortly with the additional 33 per cent.

The Highways Committee could not say whether the projected expenditure would be considered by the Board of Trade auditor who had to certify it or, in the case of dispute, by an arbitrator, to come within the term "properly expended." It appeared, however, to be quite reasonable on the part of the Borough Council to anticipate the matter by taking steps to limit the company's expenditure, and the committee thought that the Council should support the local

authority in that attitude. The company would probably be willing to consult the wishes of the Borough Council as regards expenditure which had not already been determined upon when notice of purchase was served. As, however, the provisions of the company's orders required that approval or disapproval should be intimated within one month of the notices, the County Council decided formally to disapprove the proposed works.

Shareholders in Electrical Companies.—The Local Government Committee reminded the meeting of the Council's resolution passed in May last to address a letter to the Board of Trade suggesting the desirability of there being open to inspection the lists of share and debenture holders in companies supplying gas, or electricity, or water, or hydraulic power, or undertaking tramway or telephone service, or owing docks or wharves within the county of London. The Committee now reported that a communication had been received from the Board of Trade, stating that careful consideration had been given to the views of the Council, but that the Board could hold out no hope that the Government would see its way to propose legislation on the subject.

New Electric Tramways.—The Council adjourned for a week the consideration of further schemes submitted by the Highways Committee for obtaining powers to construct four new electric tramways. The proposals relate to tramways, about 5½ miles in length, estimated to cost £175,400, including the provision of cars and carsheds and other works, whilst the sum of £87,800 is to be expended on street widenings in connection with the schemes. The tramways are (1) along the Victoria Embankment from Westminster Bridge to Blackfriars Bridge; (2) along Elgin Avenue from the proposed new tramways in Edgware Road to join the Harrow Road and Paddington tramways in Harrow Road; (3) from Trafalgar Road, Greenwich *viâ* Blackwall Lane to the southern approach to Blackwall Tunnel; and (4) from Herbert Hospital, Woolwich *viâ* Wellhall Lane to Eltham, and thence to Eltham Park.

PARLIAMENTARY COMMITTEES.

Clyde Valley Electric Power Bill.

On the clauses being brought up for adjustment, a new clause was framed which provided that in the case of failure by the company to supply energy to a corporation which had agreed to become an authorised distributor under the Electric Lighting Act, the distributing corporation should not be liable to any consumers for the consequences of such failure or for any loss or damage sustained in respect thereof. Another provison was agreed upon whereby, in the event of the local authorities of Clydebank, Dumbarton, and Kirkintilloch becoming authorised distributors within two years after the commencement of the Act they shall for the purposes of the Act be respectively deemed to have been authorised distributors at the commencement of the Acts.

Loch Leven Water Power Bill.

On Wednesday, Thursday and Friday last week a Select Committee of the House of Commons, under the Chairmanship of Sir G. Kitson, considered the Loch Leven Water Power Bill, promoted by the British Aluminium Company. The Bill sought to incorporate and confer powers upon the Loch Leven Water and Electric Power Company to enable them to construct and maintain and work water works and water power and electrical generating stations for the supply of electrical energy, and for other purposes; and to take water for such purposes from Loch Eilde Mor and Blackwater, near Loch Leven, Ballachulist. The capital of the company is to be £601,000, divided into 60,000 shares of £10 each, to be called "A" shares, and 1,000 shares of £1 each, to be called "B" shares. "A" shares will be entitled to a dividend at the rate of £5 per cent. per annum out of the profits available for dividend in respect of each year before any dividend is payable on the "B" shares for that year. The surplus profits, after 6 per cent. has been paid on the "A" shares, will be equally divided between the "A" and "B" shares.

Mr. Littler, K.C, in opening the case for the promoters, said the scheme was a portion of a more ambitious one before the House two years ago, which was rejected generally on the ground that it would interfere with the beauties of nature. He pointed out, however, that industries which might have been developed in this country had been developed in connection with the Niagara Falls, and they must have some regard to the prosperity of the country. The power they intended to produce was 18,800 H.P. The only opponents were two landowners, and the company would be prepared to compensate them for any damage sustained.

Mr. R. Wallace, K.C. (Chairman of the British Aluminium Company), was called, and said the company utilised 7,000 H.P. out of a possible 12,000 H.P. at Foyers. They were making carbide of calcium, and were also carrying on experiments in other directions for the use of electrical power for making chemicals and certain metals.

Mr. F. G. Worth, managing director of the Acetylene Illuminating Company, said that company could take 5,000 H.P. out of the 18,000 provided for at Loch Leven under the Bill.

Mr. J. F. Albright, electrical engineer, gave the manufacture of chloride of potash as an example of industries which had left this country owing to the want of a cheaper electrical supply.

Lord Kelvin, a director of the British Aluminium Company, gave evidence in support of the scheme, and said the aluminium industry had been injuriously affected by competition abroad, but the metal produced in Switzerland was no cheaper than that produced on Foyers.

In cross-examination, Witness said that before the development of water power at Niagara, and the supply of electrical energy, a great number of electrical and chemical industries which had now sprung up were altogether in the air or in the heads of the inventors.

Local evidence having been called as to the value of the scheme to the Highlands,

Mr. W. V. Graham, joint engineer of the scheme, stated that the estimate of the cost of the works and contingencies was £105,218. Land would cost £81,000, and the electric plant £79,500; a grand total of £565,718.

Counsel addressed the Committee in opposition to the scheme, but no evidence was called.

The Committee declared the preamble of the Bill proved.

Tramways Provisional Orders.

On Monday the Tramway Provisional Orders Bills, Nos. 1, 3, and which confirms Provisional Orders granted by the Board of Trade to various undertakers, came before the examiners of standing orders in the House of Commons, and the standing orders were found to have been complied with. The Bills have already passed the House of Lords. Particulars of the various orders and undertakers have already been given in the Electrical Review. The districts for which orders are asked are Ashton-under-Lyne, Denton, Devonport, Liverpool, Northampton, Pontypridd, Cheriton, Colchester, Hyde, Littleborough, Middleton and Chadderton, Coatbridge, Folkestone, Glossop, Hopeman, Weston-Super-Mare, and Pontefract.

Manchester and Liverpool Electric Express Bill.

On Wednesday last week evidence was given by Mr. P. Dawson, electrical engineer, who was a member of the Belgian jury which reported on Mr. Behr's railway at the Brussels Exhibition, and had travelled several times on the railway constructed there at a speed of between 60 and 70 miles an hour. They went round curves with the greatest smoothness. To his knowledge no other member of the jury travelled over the railway in the car. No tests were asked for, or submitted to the jury, nor were any calculations made to them. Though he protested against it, the rest of the jury came to the conclusion that the railway was dangerous. He had no reason whatever to think that the railway was dangerous.

From what you saw of the working of the railway at Brussels, did you come to the conclusion that the line was perfectly safe?—I could not see any danger about it. The jury did not wait for any results, and there were no tests made to enable the jury to come to any conclusion.

The Chairman: You travelled on this railway three or four times, and as a practical engineer no doubt were able to form an opinion that a layman could not form?—Yes.

It has been suggested to you more than once that a railway of this kind would eliminate a certain proportion of accidents. Did it not suggest itself to you that with its high speed and peculiar form of construction the railway would bring in a new class of dangers?—There might be a new class of dangers, but I do not think they would be so great as the dangers inseparable from the two-rail system.

Can you suggest what this new class of dangers is?—You have on the permanent way besides the rail on which the driving wheel runs, four guiding rails. It would be therefore necessary that the structure on which they were placed should be very carefully built. If one of the rails broke there would be a danger of a serious accident, but the danger would not be greater than the failure of a rail on the two-rail system.

What would happen if a guide rail broke?—That would have to be found out by experiments. If the rail broke inwards there might be no bad result, but if it broke outwards the momentum of the car would rip up the track and cause a disaster.

Would there necessarily be a disaster through the fracture of a guide rail?—No, not necessarily.

This concluded the case for the promoters.

Witnesses were then called in support of the opposition of the Cheshire Lines Committee, as to the estimate for the land required being too low.

M. Flamach, inspector of the permanent way of the Belgian State Railway, gave evidence concerning the mono-rail trial in Brussels, and said the highest speed attained in the experiment was 104 kilometres. As the line was constructed in Brussels a higher speed would not have been safe. The centrifugal force at this speed was 17 per cent. of the weight of the car, and at a speed of 110 miles he considered the centrifugal force would be 40 per cent In the Brussels trials considerable deflections in the rails resulted. The report made by him and his colleagues on the trials was in the nature of a compromise. He was less favourable to the new line than his colleagues, and did not consider that the Belgian State would adopt the system. He had no knowledge of their having accepted plans for the construction of such a line.

M. Jules Dery, another of the jury at the Brussels trials, spoke of the rolling and pitching movements of the cars, and said that at the president of the Exhibition stated that he could not give the prize for high speed to Mr. Behr because his system was dangerous.

The Committee adjourned.

On 18th inst. Mr. D. Meldrum, manager of the Cheshire Lines Committee, gave evidence in opposition to the Bill, and gave details of the train service between Liverpool and Manchester. He contended that the public were adequately served, and that there was no need for the mono-rail.

Mr. Francis Fox, C.E., engineer to the Cheshire Lines Committee, who was connected with the building of the Liverpool Overhead Railway, expressed the opinion that the mono-rail system was based on unsound scientific principles, and he considered it unsafe. Placing the rail on an unstable structure above the ground would bring about sinkage on the mosses over which the railway had to travel. There was three times the material in the mono-rail than there was in an ordinary line, and a depression on the mono-rail would set up a series of sinuosities which would be fatal to the safety of the line. This would lead to derailment, the results of which would be far more disastrous than in an ordinary railway accident.

At the Committee resuming on 19th inst., further consideration was given to this Bill.

Mr. Francis Fox, C.E., in examination said that he should describe the proposed line as a sort of glorified "Ballybunion" line which he said was an engineering as well as a financial failure, and was really detrimental to the locality. He contended that the defects of that line would be repeated in the present scheme. In the mono-rail system, the danger of the cars mounting the line was more pronounced than in the case of the bi-rail system. The guide wheels would not avail to counteract centrifugal force, and he believed that the whole thing would go to pieces.

Cross-examined by Mr. Fitzgerald, K.C., Witness said there must be a perfect adjustment of the guide wheels, and this could not be secured with any certainty in the proposed scheme.

Mr. W. O'Neill, chief engineer to the Midland Great Western Railway of Ireland, said the result of his investigation of the merits of the mono-rail line in 1898 in connection with the Listowel and Ballybunion Railway, was that the suggested line would be impracticable. The oscillation and noise of the cars were enormous, but the main difficulty was due to subsidence of the permanent way, which would lead to "kinking" of the mono-rail. The kinks would become permanent, and it would be of course impossible to run over the line at high speed, for there would always be the danger of a serious accident. Despite the very little traffic on the Ballybunion Railway, there were frequent renewals of the trestles. When he had travelled on that railway he had always experienced an extremely unpleasant sensation. He did not believe that a speed of 110 miles an hour could be accomplished on the mono-railway. There was no doubt that a very much higher rate of speed could be obtained on the bi-rail system than on the mono-railway if sufficient money were expended on the permanent way and rolling stock. The centre of gravity on the Ballybunion Railway was above the rail; it might be brought down lower, but beyond steadying the car it would not have very much effect on the danger of derailment. The Ballybunion Railway spent 90 per cent. of its receipts in working expenses.

Replying to the Chairman, the Witness said the train would be safer with no flanges to the mono-wheel than with flanges, and more comfortable with springs than without them, although more dangerous.

Mr. Barton, C.E., stated that he had laid down hundreds of miles of railways in Ireland, and had studied the proposed mono-rail system. In his opinion it was still in the experimental stage. There were half-a-dozen dangers which he had thought of, and which could be explained in a simple way—though he was sure there were a great many more. He mentioned a number of dangers to which he considered the mono-railway would be subjected.

Cross-examined by Mr. Fitzgerald, Witness said in his opinion the mono-rail should not be sanctioned until experience proved its safety.

Mr. Fitzgerald said the dangers which had been put forward by Mr. Barton constituted new evidence. It had been given from plans and diagrams, and he could not cross-examine upon it, and would therefore ask to be allowed to recall Mr. Cooper, one of the engineers to the promoters.

The Chairman said he agreed to this, as the Committee were only desirous of getting at the truth.

The Committee adjourned till Monday.

On Thursday Sir Douglas Fox gave evidence as to the competition with the Cheshire lines which the proposed mono-rail would create, and pointed out that at the Liverpool end the acquisition of land by the promoters would prevent the carrying out of a projected new dock. He expressed the opinion that considering the little time which would be saved by the construction of the line by passengers between Liverpool and Manchester the game was not worth the candle. He thought the machinery of the mono-rail system was much too complicated for practical purposes, and that the weight of the car was out of all proportion to the number of passengers to be carried.

In cross-examination, Witness said he considered the chain a most dangerous factor, and so far as the guide-wheel springs were concerned, the ½-in. play that had been suggested by the promoters was an absurdity.

Prof. Carus Wilson said he saw great difficulty in the placing of a motor of sufficient power within the car on the proposed system. The trains could not be brought up within a mile or one minute, because on the mono-rail system the brake and wheels were boxed up, and consequently were deprived of the cooling action of the air. Ordinarily, the greatest pressure upon the flanges of the wheels on a bi-rail was 10 per cent. of the weight of the coach or car. The maximum pressure on the main driving wheel in going round curves on the proposed mono-rail system was 24 per cent. of the weight of the car. Witness thought the outside limit should be 15 per cent. in a motor-driven car, and this only when the guide wheels were both taking their share of the pressure. On the proposed line there were, furthermore, dangerous reverse curves. In other words, the car would not have recovered from the shock given it by a curve in the rail in one direction before it received a second shock through the rails curving in the reverse direction.

Mr. S. H. Short, technical director of the English Electric Manufacturing Company, was then called, and examined by Mr. Russell, K.C. He said he was of opinion that the system was defective. He did not think that the mono-rail car was to be constructed sufficiently strong enough to be able to stand the wear and tear of the high speed travelling. Witness here produced a strip of metal, which, he said, was the identical composition of aluminium and magnesium with which Mr. Behr had arranged to construct his car. He also produced strips of wood and another metal of the same weight, and, placing the first-mentioned across his knee, broke it in half with ease. The wood he failed to break, and the third strip he was able to bend. He expressed his opinion in support of the experiment that the car might get smashed up. It had been shown from experience that wood was the best substance of which to construct railway cars, and nothing was to be gained by attempting to reduce the weight of cars below what had been found serviceable on railway lines in general. He further argued that the size of the car was not sufficient to admit of a motor powerful enough to drive the car as fast as was desired. He calculated that the chain proposed by the promoters would only last 180 journeys between Manchester and Liverpool. If it broke it would certainly fly through the bottom of the car if it went in that direction.

The Committee adjourned.

London County Council Tramways.

On Wednesday last week local evidence was given in favour of the scheme by the Rev. J. R. Lees, vicar of St. Andrews, Lambeth, and Mr. W. Mitchell and Mr. A. T. Moore, members of the Camberwell Borough Council.

Mr. H. L. Cripps, the Parliamentary agent to the London County Council, gave evidence as to the negotiations which he conducted on behalf of the Council last year with the various local authorities in London, with the object of securing uniformity in the relations between the Council and the local authorities. An agreement was come to which was incorporated in clauses inserted in the London County Council Act of last year, which authorised the Council to convert the existing tramway system of London to electrical traction. The scheme contemplated that before the works were commenced a detailed plan, with a statement of the materials to be used, should be submitted for approval to the Board of Trade, and that all the road authorities who were responsible for the repair and maintenance of the roadway, as distinct from the tramway authority, should have an opportunity of being heard. Battersea wished to have the whole agreement altered in their favour, simply because half-a-mile of tramway was made in their district. The whole question of electrolysis was considered when the clauses were agreed to last year, and those clauses were included in the present Bill.

This evidence concluded the case for the County Council.

Mr. Balfour Browne, K.C., in addressing the Committee, on behalf of frontagers whose property would be injured by the construction of the tramways, said the question really was whether the frontagers were to have any rights at all, or whether the County Council was to have the privilege of construction tramways wherever it thought fit.

Evidence was then tendered by various witnesses in opposition to the scheme, and the Committee adjourned till Monday.

After hearing a considerable amount of evidence in opposition to the Bill, the Committee gave their decision on Tuesday last.

The Chairman said the Committee had decided that they could not sanction the proposed line from Camberwell Green to Dulwich, or the line which was to have run along Stamford Street over Blackfriars Bridge, or the proposed extension of the line in Waterloo Road so as to bring the tramways nearer to the bridge. They had decided to authorise the construction of the remaining extensions as authorised by the Committee of the House of Commons. The opposition of the Battersea Borough Council was met by the insertion of a clause reserving to the borough, as the electrical undertakers in their area, the right to break up the new tramway in Battersea for the purpose of laying electric lines where necessary.

Lowestoft Tramways Bill.

A Select Committee of the House of Commons, under the chairmanship of Sir Frederick Godson, on Tuesday and Wednesday, considered the Bill of the Lowestoft Corporation which has already passed in the House of Lords.

Mr. Freeman, K.C., who represented the Corporation, stated that the chief thing dealt with in the Bill was the provision of tramways. The Corporation had taken over the electric lighting of the borough, and in connection with that, tramways had suggested themselves. If they got tramways it would result in considerable economy, as they would be able to have a day as well as a night load. In 1899 a company applied for power to construct a tramway from Yarmouth, through Lowestoft to Kessingland, but as the result of the opposition of the Great Eastern Railway Company, only a part of the scheme was sanctioned. Subsequently negotiations took place between the Corporation and the company, and an agreement was

come to which was very advantageous to the Corporation, the result of which was that the company agreed to withdraw their application for the confirmation of their light railway order so far as it applied to lands within the borough, and the Corporation agreed to apply for power to construct a tramway between the borough boundary on the north and the borough boundary on the south. They were now asking for power to construct a tramway along the whole front of the borough, and it would be in immediate connection with the tramways outside. Originally it was intended to construct more tramways than shown on the plan, but a part of the scheme had been taken out, thereby considerably reducing the borrowing powers which were required. It was now proposed to expend £60,000 on the tramways.

Mr. R. B. Nicholson, town clerk of Lowestoft, said that if the Bill was passed the Corporation proposed to lease the tramways to a company, and the company would be obliged to take their electricity from the Corporation. This agreement was conditional upon the company raising the necessary capital. The debt of the borough was £106,000, of which £35,000 was for the electric light undertaking. The Corporation would be assured that the company were in a position to work the tramways before they handed them over, and failing them being handed over there would be a remunerative undertaking in the hands of the Corporation.

Mr. W. Beer, engineer of the Bill, said he was also engineer to the East Anglian Light Railway Company. The proposed lines were 7¾ miles in length wholly within the borough. The gauge of the tramway would be the same as that of the East Anglian Company, so that they could have a continuous run from one to another.

Further evidence was called to show the necessity for tramways and the prospects of their proving remunerative.

Mr. Littler, K.C., for the opponents, argued that the liabilities of the Corporation were already high enough, and it was very undesirable that they should be increased.

Evidence was called in opposition to prove that the streets were too narrow for tramways, and that the traffic would be so little in the winter that the scheme would not be remunerative.

The Committee found the preamble of the Bill proved.

Metropolitan Electric Supply Company.

The Bill of the Metropolitan Electric Supply Company, which has already passed the House of Commons, came before Lord Morley's Committee on Unopposed Bills on Tuesday. The object sought under the Bill is to carry out an order of the Board of Trade under which the Board consented to an extra high pressure being given by the company, but with the condition that at least two separate and distinct trunk lines be laid to each of their distributing mains.

THE MERCADIER MULTIPLEX TELEGRAPH.

(*Continued from page* 124.)

The period or frequency of the induced current is equal to that of the corresponding tuning fork. To prove this it is merely necessary to join a telephone to the circuit, C *l*, at some point and depress the key, *m n*. The note heard in the telephone is the same as that of the tuning fork. If all or several of the keys are depressed simultaneously, the various induced currents of different frequency pass without confusion in the circuit, C *l*. At the same time an equal number of currents of equal frequency are induced in the secondary coils (2) of the coils, B *e* and B *l*, and by means of the two wires, *f e* and *f l*, of the relay R *d*, on the real line, and also in the extinguishing circuit, C *e*, through the artificial line, L *e*.

Twelve mono-telephones are joined in series in the receiving circuit, C *r*, to form the multiplex receiver. The actual apparatus (fig. 6) is composed of a cylindrical box covered by a glass cover which encloses a strong magnet of which N is the hollow core. The core is covered by a coil, E, as in an ordinary telephone, but the diaphragm, which is about 2 millimetres thick, instead of being fastened at its circumference is simply held on three points of the circumference of the first Nodal line by three fixed supports, *t*, which are attached to movable radiating slides on a shelf of the circular platform (P) which supports them. The diameters of the diaphragms are determined by the condition that they give for their first harmonic the sounds, si_3 (B) (480 vibrations per second), ut_4 (C) (512 vibrations), *ut dieze* (C sharp) (543 vibrations), and so on, semi-tone by semi-tone, to *la dièze* (A sharp) (about 900 vibrations). Each of them is exactly tuned to syntonise with one of the electro-tuning forks used in the transmitter.

When a series of undulatory currents passes through the coil E, of a frequency equal to the first harmonic of the membrane, there is an energetic response, whilst if the frequency is different to the extent of a semi-tone, the membrane remains nearly unmoved. Hence the name mono-telephone given to the instrument, which responds only to a single sound. The mono-telephones, being characterised by their particular note, are known briefly as the receiver B, C, or F, &c.

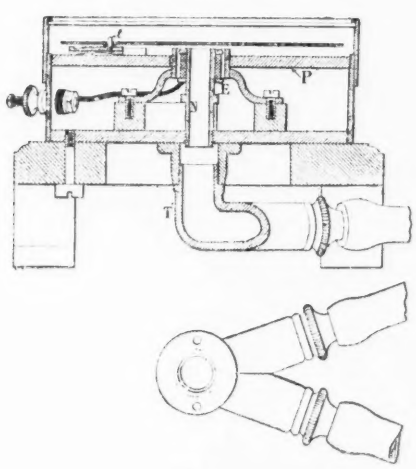


Fig. 6.

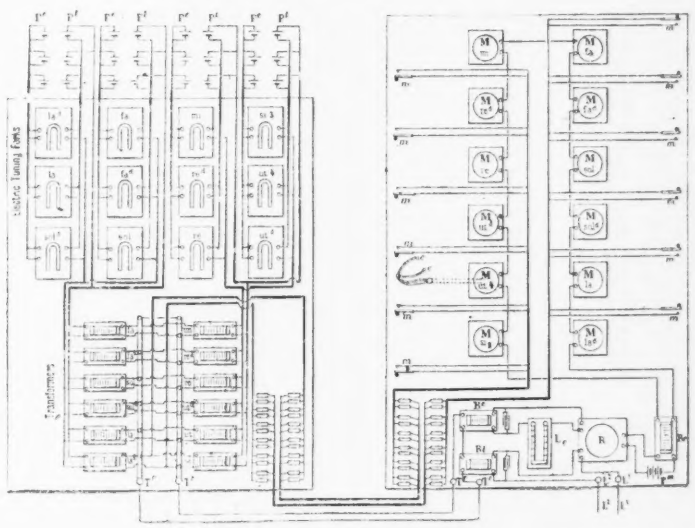


Fig. 7.

For the collection of the sonorous waves produced by one of these receivers vibrating under the influence of signals sent by undulating currents of the same frequency as its own, a tube, T^1, is attached to the hollow core of the electro-magnet E, and bifurcated, the two branches, communicating by light, flexible tubes with the ears of the operator. The tubes are held to the ears by a steel spring in the form of a **U**, which passes under the operator's chin. A sketch of one of these *ecouteurs* (listeners) is shown in fig. 7, lower portion. The coil of the electro-magnet is wound to a resistance of 200 to 400 ohms. The platform P, which supports the discs, is attached to the base of the apparatus in such a way that the core of the magnet can be adjusted in relation to the diaphragm of the mono-telephone. In fig. 4 three of these mono-telephones are shown schematically. In actual practice 12 mono-telephones are used, ranging semi-tone by semi-tone from B to A sharp.

From the above description it is easy to see how signals can be sent and received simultaneously. Suppose the tuning forks in motion at each station. At the station A an operator sends Morse signals with the key *m n* (fig. 4) related to the tuning fork si_3 for instance; these signals are reproduced

by induction in the secondary coils of B *e* and B *l*, those of B *l* going to line and traversing the wire *f l* of the relay R *d*; but their effect on the relay is annulled by that of the signals simultaneously produced in the coil B *e*, and which traverse the artificial line L *e* and the wire *f e* of the relay, when the line L *e* and the condensers are properly adjusted. The relay remains unmoved, while the signals go to line, and arrive at the remote station (B), traversing the wire 2 of the coil B *l* and the wire *f l* of the relay R *d* of the receiving station (B). There they are not annulled, the microphonic contact *p m* moves, and produces the signals in wire 1 of the induction coil B *r*; wire 2 reproduces them by induction, and they pass through the mono-telephones in the receiving circuit *cr*. But as only the mono-telephone Si_3 is affected by these signals, the operator at this receiver receives the signals sent to him by the operator at transmitter Si_3 of the sending station (A).

At the same time the operators at the other points can be exchanging signals in a like manner without any confusion. By this means with 12 transmitters and 12 receivers at either station it is possible to effect 24 simultaneous transmissions. Fig. 7 represents a complete installation such as has been employed on trial at the central office of Paris. The annoyance likely to result from the presence of the large number of tuning forks and mono-telephones in one room has been overcome by enclosing them in a felt-covered cupboard at some distance from the working table.

It is impossible to surmise what will be the result of the experiments carried out in England between London and Glasgow, but it is stated that excellent results have been obtained between Paris and Dijon, Paris and Toulouse, and Paris and Bordeaux. At any rate, the principle of the system cannot fail to be of interest to British electricians.

The inventor has worked out some ingenious methods of interconnection of a number of stations in *echelon*, and has devised many methods for overcoming the more obvious difficulties of the system.

CORRESPONDENCE.

Localisation of High Resistance Breaks.

Absence from England has delayed my reply to Mr. H. R. Kempe's comments on my article explaining the above test in the Electrical Review of June 7th and 14th, which I received only yesterday. I hasten to thank Mr. Kempe for his kindly reference to the merits he recognises in the test. I was of course well acquainted with Mr. Kempe's test for high resistance breaks based, as all such tests must be, on the measurement of capacity and resistance, but he will forgive me when I say that although his test is theoretically sound, and I doubt not capable of giving good results to an electrician so expert as he is, it is a little formidable to the average electrician, whose results would not, I think, be equally reliable and satisfactory ; and it is for this reason that I devised an alternative method more simple, I think, in execution and involving a less elaborate formula.

I fully endorse what Mr. Kempe says when he points out that " when R *l* is very high then any variation in this value but very slightly varies T A B *l*," and I evidently did not express myself sufficiently clearly as to what I meant by the statement which Mr. Kempe rightly considers to be not strictly correct if applied to two *high resistance* breaks differing considerably in their resistance.

It will be seen, however, that in the previous paragraphs I had just contrasted the relative charges in the cable part of the circuit with the *end sealed*, the end *direct to earth*, and also when the break resistance equals that of the cable conductor (p. 961), and the conclusion I expressed was intended to be only a general remark, applicable not to two high resistances differing in value, but to a high resistance as contrasted with one of low or moderate resistance, viz., that " the higher the fault resistance the greater the charge in the cable, because the potentials in the cable portion of the circuit are higher. Moreover, the higher the fault resistance the more cells may be used to increase the charge. It will, therefore, be seen that a high resistance tends to increase the efficiency of the localisation which depends on the charge being large enough to be accurately measured." This, of course, is strictly correct.

That I was considering only high *versus* low resistance breaks is more clear perhaps from the next paragraph where I said " The lower the fault resistance the more advantageous is it to employ a rather low galvanometer resistance," which would, of course, only apply to a very low resistance circuit. Also in the Addendum (p. 1008—1009) " This test is applicable for breaks of low or very high resistance, but has been specially designed for the latter, as other tests in common use are better suited for breaks of very low resistance, because the charge taken up by the distant portion of the broken cable would be small for very exact measurement."

With regard to the separate and important consideration raised by Mr. Kempe as to the degree in which a decided increase in an already high break resistance affects the charge in the cable it is true, as pointed out by Mr. Kempe, that the difference in the cable potentials, and therefore in the measured charge, *f*, represented by T A B *l* would be very slight in the two cases, but on the other hand, the higher break resistance would not very greatly alter the total imaginary charge, F, represented by T A E, owing to the charge towards the distant end of the circuit being very attenuated compared with the testing end. A slight error in the measurement of *f* does not therefore seem to affect the ratio $\frac{f}{F}$—indicating the distance of the break—very seriously. Or to put it in other words :—The charge in the real cable part of the circuit is so much larger than that for an equal resistance at the distant end of the imaginary cable circuit, A B E, that a small error in measuring the former apparently does not vitiate the calculated distance of the break in a very important degree. This seems confirmed by the accuracy of the results of tests on the higher resistance faults which I have submitted for publication since my original article appeared.

J. Rymer Jones.

Coatzacoalcos, Mexico.
July 5th, 1901.

Purchase of Foreign Machinery.

I have been in the electrical engineering business for 20 years, and up till six or seven years ago I dealt exclusively in British machinery. At first delivery was of no importance, but as business increased and British firms showed no inclination to increase their plants and staffs, delivery became worse and worse, and caused trouble. Then many dynamos and motors proved failures, and finally the business methods of British firms became quite intolerable, till finally I was induced to look into foreign machinery, and have been very well satisfied therewith ever since.

The matter of delivery is entirely in the manufacturer's own hands ; it is too much to expect purchasers to treat with any consideration manufacturers who will not, in the face of keen competition, help themselves. In my opinion it would only be putting a premium on incompetence to grant longer time for delivery to the slowest manufacturer.

Then, again, too much stress is put upon superior British workmanship. I could give, and no doubt many others could give, many examples of dynamos and motors of faultless workmanship and mechanically unsurpassable for durability, which were utter failures.

One thing I admire most in American dynamos and motors of high class, is their faultless design, and the chief reason for my preference is that in British machines the electro-magnet designs are mostly faulty, and hence a magnificently-made machine, so far as workmanship goes, is often a failure.

I have a case in hand now of a finely-made dynamo supplied by an eminent firm in Britain ; but although well made, the design is faulty, hence great dissatisfaction with it. In another case a large machine by a British firm, splendidly made, but an utterly bad design ; the purchaser, on the advice of competent engineers, rejects it.

The reason for these faulty designs is not far to seek. We have only got to compare the calibre of the British and foreign designers engaged by the largest firms.

A glance at the advertisement columns shows this feature of British manufacturing, "A MAN wanted to keep costs, manage works, design and build dynamos, alternators and polyphase machinery." It is ludicrous to read such things.

How would this look in an architectural paper?—"A man wanted to act as clerk of works, manager, mason, bricklayer and carpenter, competent to design mansions, churches and cathedrals."

It is useless to attempt to fasten any blame upon purchasers and their advisers; the culprit is the manufacturer himself. He himself must move in the matter first, and thereby become worthy of consideration. The electrical engineering trade has slipped through his nerveless hands, largely due to his inability or unwillingness to pay for talented designers. There is no other way of accounting for the failure of otherwise faultlessly made machines than by laying it against the design. We are too apt to talk of the vagaries of our workmen and of consulting engineers, while blinking the facts regarding the men who must move or block the way.

As to business methods, I have found British firms exceedingly difficult to deal with when their manufactures prove faulty; their invariable attitude is one vulgarly described as "bluff."

A case in point. A number of motors by a large firm failed within eight days of starting up. Although the failure caused great loss and delay, only on compulsion was it attended to, and then they laid the blame on the starting switches, thus claiming exemption from all blame. Unfortunately for this contention, they had forgotten that the starters were their own, fitted by themselves!!!

It is poor business policy to attempt to make a purchaser pay for faulty machinery without first cheerfully and readily and promptly attending to it.

These lines are written merely to show that there are deeper reasons at the bottom of the purchase of foreign machinery than appears on the surface.

No doubt my experience has been that of others, and it will take more than quick delivery and good workmanship to induce me to advise the purchase of machinery made as at present in Britain for heavy engineering work, however much I should like to do so.

A Consulting Engineer.

Refuse Destructors and Electric Generation.

Now that the fallacy that the dust bin can be considered the source of the future light has been exposed by Mr. Highfield, one would like to hear the views of Mr. Kershaw and also those of the engineers of the much-advertised Shoreditch installation upon this interesting subject.

Voltmeter.

July 21st, 1901.

THE RASCH ELECTRIC LIGHT.

THE glow worm has long been the envy of the electric lighting engineer. This ingenious animal manages somehow to produce light, which, though not of great intensity, is unaccompanied with any waste heat rays; the whole of the radiant energy which it produces is within the limits of the visible spectrum, and we are justified in assuming that 100 per cent. of the energy applied is converted into light.

The case is very different with our artificial contrivances for obtaining light. The ordinary gas light converts only about 1 per cent. of the applied energy into light, the ordinary electric incandescent lamp converts about 5 per cent., the Nernst incandescent lamp, which is somewhat slow in making its appearance on the market, converts 10 per cent. of the applied electric energy into light, and the ordinary arc lamp about 30 per cent.

It is evident, therefore, though we are still far short of the ideal, that a considerable advance has been made in the efficiency of light production during the past century. Some investigations recently made by Herr E. Rasch, of Potsdam, seem to indicate that the new century will see a much greater advance in this direction than any that has hitherto been made—an advance which actually threatens the enviable pre-eminence of the glow worm.

Shortly stated, Herr Rasch's invention consists in taking the same refractory materials as are used in the rod or filament of the Nernst lamp, and using them to replace the carbons of the ordinary arc lamp. By this method, a beautiful steady light has been obtained, whose light is equivalent on an average to 75 per cent. of the electric energy applied, and in some individual experiments (assuming that there was no experimental error) the theoretical limit of 100 per cent. appears to have been reached.

Rasch's object appears to have been to use the same materials as used by Nernst, but to increase their efficiency as radiators of light by raising them to a higher temperature. For this purpose he reverted from the incandescent to the arc system of lighting. He obtained an excellent steady arc light between electrodes of magnesia, lime, thoria, zirconia, &c., but as in the Nernst lamp the electrodes had to be subjected to a preliminary heating to make them sufficiently good conductors to transmit the current.

The preliminary heating may be effected in a simple way by an auxiliary carbon arc lamp, which arrangement, though some mechanism is necessary, is not more complicated than the preliminary heating appliance in the Nernst lamp. The carbons of the arc lamp can be arranged to transmit the current to the ends of the electrolytic electrodes, after the preliminary heating has been accomplished.

The density of the flow of energy on the glowing ends of the electrolytic electrodes is very great (30 to 40 watts per mm.^{2} and more). The temperature there is the highest which can be produced with the terrestrial materials at our disposal, corresponding as it does to the enormous temperatures required to vaporise the most refractory materials known. The amount of light produced per unit of electric power applied ought on that account to be greater than by any other known system, and this anticipation has been fully justified by experiment.

The incandescent light and the Nernst light give continuous spectra, but the Rasch light gives the line and band spectra which have only been obtained with the highest temperatures, another proof of the great advance that is to be expected from this method of producing light. The light obtained from magnesia or zirconia electrodes is white as sunlight, and, compared with the carbon arc light, has a much more beneficial effect on the eye.

The development of light is not confined to the glowing ends of the electrodes: the gaseous electrode particles take a considerable share and form a pure white, softly luminous and sharply defined gas corona. This gives rise to a much better distribution of light, and softens the intense glare of the electrode ends.

It is further possible by this system of lighting to produce a great variety of decorative effects with coloured lights by choosing suitable materials for the electrodes. Electrodes of magnesia, fluoride of calcium, oxide of chromium, oxide of nickel, give a light which is, for example, decidedly yellow compared with the carbon arc light.

Rasch has made a number of experiments to ascertain the properties of these refractory materials when used in the electric arc lamp. It is convenient to distinguish between materials with a very high resistance when cold and a high starting temperature; and substances with a moderately high conductivity in cold condition and a relatively low starting temperature. For the sake of brevity these two classes of substances are called "hard" and "soft."

Electrodes can be made so soft that they require no preliminary heating and will light up with a convenient high potential difference. It has been found, however, that such electrodes have a much lower efficiency than hard electrodes that require a preliminary heating. The arc, with soft electrodes, is unstable, and very similar to arcs obtained with metal electrodes. With soft electrodes the P.D. of the arc remains practically constant for all lengths of the arc, while, with hard electrodes, the P.D. rapidly increases with its length, as in the carbon arc. Soft electrodes have also a tendency to fuse at the ends and form a bridge across the arc, which extinguishes it.

The conclusion arrived at from these results is that the more rapidly the P.D. of the arc increases with its length, the more economical is the arc, and the better and more stable is the emission of light. When the P.D. coefficient $n = 0$, a stable arc is not possible.

With moderately hard electrode materials, the preliminary heating of which can be done by a match or a Bunsen flame, Rasch has found the following formula to hold—

$$E = (m + n e) \text{ volt.}$$

The constants with the current of 2·6 to 2·1 amperes are according to the nature of the material :—

$m = 38$ to 43
$n = 16$ to 17 and greater.

Since the P.D. of the arc also depends on the intensity (C) of the current, as expressed by the formula

$$E = k + \frac{b}{C},$$

the determination of the constants b and k was made with a constant length of arc ($e = 1$ mm.), the current being varied within limits by a rheostat. The result of the experiments are shown in fig. 1.

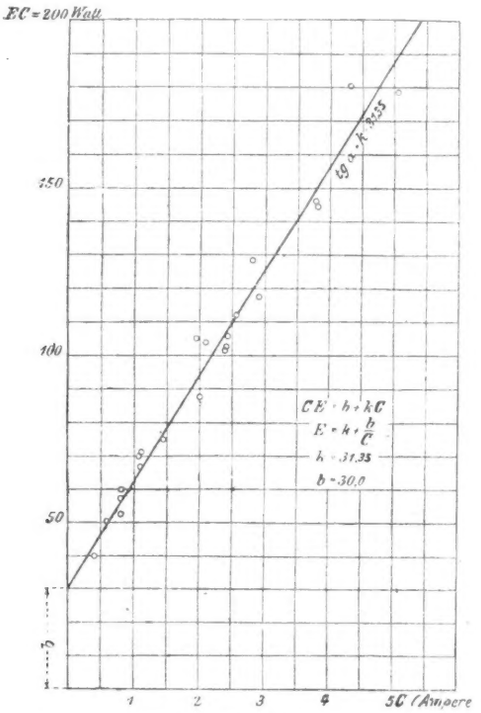


Fig. 1.

The tangent of the straight line gives, as is evident, the constant k; the ordinate for $c = 0$ is $= b$. For the electrodes used in the experiment, the values found were :—

$k = 31{\cdot}35$
$b = 30.$

The constant k signifies the potential drop at the boundaries of the two electrodes. For the continuous current arc, $k = 43$ and $b = 32$. With other somewhat harder electrolytic electrodes, the values found were $k = 42$ to 43. It is evident from these figures that the pressure relations are practically the same with the electrolytic as with the carbon arc.

The laboratory experiments were made on electrodes up to 5 mm. diameter, and with alternating currents. It is probable that with electrodes of larger diameter and with continuous currents the light given out would be greater—as is the case with the carbon arc lamp.

However, such experiments as have been made give undoubted proof that the electrolytic arc lamp is the most efficient of all sources of light.

As may be seen from the figures in Table I., electrodes of 2·5 mm. and 5·0 mm. diameter burn equally well, giving 600 to 1,000 candles, at a rate of 3 to 4 candles per watt. The consumption of power per candle-power (Hefner candle) for lights of this size amounts therefore to 0·25 to 0·3 watt.

Table I.

Diameter of electrodes, 2·5 mm. s = 4·91 mm.²

Volts.	Amperes.	Watts.	Intensity (horizontal) Hefner candles.	Watt Hefner candles.	Efficiency in Hefner candles per hektowatt.
51	3·05	155·6	567	0·275	364
53	3·00	159·0	732	0·217	460
45	3·10	139·5	629	0·222	450
52·5	3·00	157·5	629	0·251	399
53	2·99	158·5	602	0·263	380
	Average ...		632	0·246	407

Diameter of electrodes, 5 mm. s = 19·6.

Volts.	Amperes.	Watts.	Intensity (horizontal Hefner candles.	Watt Hefner candles.	Efficiency in Hefner candles per hektowatt.
39·0	5·2	203	962	0·211	474
43·0	5·3	228	738	0·309	324
35·0	5·3	191	929	0·206	486
38·0	5·3	201	704	0·286	350
47·0	5·3	249	1,059	0·235	426
45·5	5·3	241	995	0·242	413
	Average		898	0·248	404

The relations between pressure, current, and candles per watt, as the results of an experiment with a constant length, e, of arc, are given in Table II. The candles per watt increase with the electric power expended in the arc. The relation may be expressed by the formula,

$$H = 0{\cdot}028 \text{ (watt)}^2$$

where H is the intensity of the light in Hefner candles.

It is worthy of note that the efficiency rises to 5·21 candles per watt, and then falls off, which is due to the fusion of the electrodes at the exceedingly high temperature produced. Tumlirz in his investigations "On the Mechanical Equivalent of Light" (*K. K. Akademie der Wissenschaften*), shows that the ideal 100 per cent. efficiency corresponds to 5·21 Hefner candles per watt, *i.e.*, 0·19223 watt per Hefner candle. This ideal physiological effect can evidently be reached by the electrolytic arc light. Fig. 2 shows the relation between the pressure and the current. Table II. gives the data of the experiment.

Table II.

Light efficiency with constant length of arc e. Diameter of electrodes 2·5 mm.

Volts.	Amperes.	Watts.	Candle-power.	Candles per watt.
65	1·09	70·9	146·2	2·06
65	1·25	81·3	191·4	2·35
58	1·70	96·6	275·0	2·85
55	2·15	118·3	398·5	3·37
51	2·60	182·6	498·4	3·76
51	3·25	165·8	780·6	4·71
47	4·00	188·0	994·0	5·2
45	5·00	225·0	1,012·5	4·50

Though it is evident that we have not the best working conditions with a constant length of arc, yet even with these unfavourable conditions, the above data show that it is possible to get high efficiency with moderate density of watts in the arc, and it is especially important to note that highly economical lamps of 100 candles may be made with the electrolytic arc.

Fig. 3 shows the relation of the efficiency of the electrolytic arc lamp to the efficiency of other kinds of lamp. It is evident from this diagram that the electrolytic arc is more than twice as efficient as the carbon arc, though alternating currents were used in the former case, and continuous currents in the latter.

Table III. gives the numbers representing the efficiency of the different kinds of lamps.

Table III.

Kind of lamp.	Candles per watt.	Watts per candle.
Electric incandescent lamp	0·29	3·0—1·0
Nernst lamp	0·66	1·5—1·6
Ordinary arc lamp—alternating current ...	1·25	0·8
„ continuous „ ...	2·00	0·5
Electrolytic arc	3—4	0·25—0·3

It is to be noted that the new arc light, even with present high prices of current, is considerably cheaper than the Welsbach incandescent gas light.

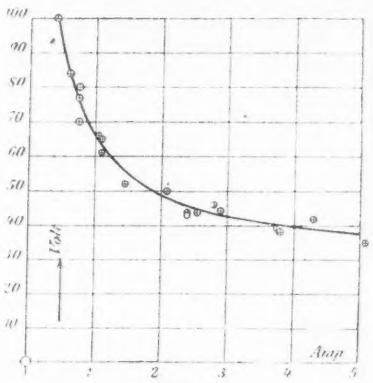


Fig. 2.

Another important point is that the electrolytic electrodes, being incombustible, last longer than carbon electrodes; they are also very small in diameter and easily manufactured.

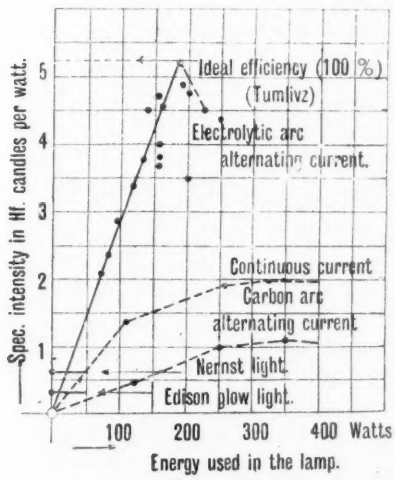

Spec. intensity in Hf. candles per watt.
Ideal efficiency (100 %) (Tumlivz)
Electrolytic arc alternating current.
Continuous current Carbon arc alternating current
Nernst light.
Edison glow light.
100 200 300 400 Watts
Energy used in the lamp.

Fig. 3.

Herr Rasch's investigations are highly interesting as pointing out a way by which electric lighting may be enormously cheapened. But it does not appear that the new lamp has yet reached a practical form, and after the experience of the manufacturers of Nernst lamps, it is well to remember that there are many steps, some perhaps insurmountable, between the laboratory and the factory.

REVIEWS.

The Motor Engineers' and Electrical Workers' Handbook. E. and F. N. Spon. 2s. net.

We are inclined to ask, after reading this book, for a definition of a motor engineer. The term, like the book, is American, and we suspect that it signifies a motor inspector, otherwise a promoted motorman. The introduction states that the handbook has been compiled "with a view of furnishing a book of reference . . . . for motor engineers and street railway men"; but, so far as we can see, the greater part of 52 pages out of the 147 in the booklet contain the most elementary instruction in electricity. If a "motor engineer" requires to be taught the A.B.C. of electricity, he ought to learn it from text-books which do not run from the definition of a volt to testing for faults in 60 pages.

It was with much tribulation that we read the "handbook." Never before—not even in the shorthand report of the discussion on an American paper on electrical matters—have we been so agonised with construction, elision of articles, and absence of punctuation. One example of what is to be found on almost every page will be more than enough:—"Meanwhile, the coils on the other side belonging to the same loop approaches and passes the pole marked s, or south pole, and is likewise acted on by that pole and current flows in the direction indicated by arrow, and while it is apparently flowing in an opposite direction, it is really going the same way, owing to the coil being in a loop and both electromotives forces are added together, that is to say that if the electromotive force generated at each pole is one volt, that generated at both poles are two volts, and as it is one circuit the current is the same." There's a sentence for you!

The rule for finding the joint resistance of two circuits of unequal resistance is an amusing example of redundance:—"Multiply the resistances together, divide the product by their sum when added together." On the next page this rule is repeated, and the following example is given:—"What is the joint resistance of two circuits, with a resistance of 10 and 20 ohms respectfully?" Another example on the same page contains the same error.

The printer has added considerably to the bad spelling in this book, and he may be responsible for the queer ways of spelling "parallel." The arithmetic is generally correct.

Chapters V. and VIII. are by permission of the Westinghouse Company, and contain their instructions for operating generators and car apparatus "respectfully." On p. 18 the author states that the "ground part of the circuit is often used for the outgoing lead on street railways."

The following, found on p. 49, seems to require amendment:—

"Electric losses [presumably of traction motor]—

{ Field current (constant).
{ Foucault current (constant).
{ Hysterisis (*sic*)."

Chapter VII., on the tests of street railway motors, is the first of any interest.

Pages 72 to 76 contain the Westinghouse instructions to motormen, for which the motor engineer should have no use.

The longest and the best chapter in the book gives diagrams of connections and combinations of the Westinghouse G, 14, 28 and 28A controllers; the General Electric K, K2 and magnetic brake controllers; the Walker B2 and E; and the Steel Company's C, No. 3 controller.

The only mistake in the diagrams of combinations is evidently a slip, the diagram of the K2 showing No. 2 motor open-circuited on the last notch.

There is a minor error on p. 112, concealed in a mystic sentence: "The blow-out magnet (K2 controller) is so arranged, that one of the poles consists of the iron plates between the cylinder rings, and the plate faces those plates, and the lines of force cut across the spaces at which the contacts are made with cylinder strips."

The seventh chapter makes the book worth the 2s. asked by the publishers.

Deschanel's Natural Philosophy. Part III. Electricity. An expansion of Everett's Deschanel on the lines of Modern Electrical Theory. By J. D. Everett, M.A., D.C.L., F.R.S.

Adopting the general form, and making use of much of the old matter and many of the illustration of the familiar Deschanel, Prof. Everett has written a new book on electricity. It need not be said that it is sound, accurate, and scholarly. The large area of the science is fairly well covered, the new illustrations are generally good, and the new subjects

dealt with are interesting and well chosen. Nevertheless, it is a sad example of the result of putting new wine into old bottles. The charm of the old edition was due almost entirely to the beautiful illustrations of apparatus and experiments, scarcely at all to the scientific commentary; and the last 20 years have added so greatly to our store of striking experiments that there was an excellent opportunity for a new edition of the work developed on its own characteristic lines. Lodge's work on electrical discharges, and on dust; Chunder Bose's apparatus for Hertz rays; and the experiments of Tesla and Elihu Thomson; these and numberless other subjects are admirably suited to treatment of the character of the old edition of Deschanel. On the other hand, one does not look to a book of this kind for discussions of the mathematics of Heaviside and Poynting, the dimensions of units, the curl of vectors, the theory of the propagation of signals through cables; and it is impossible in a volume of 350 pages to afford room both for work of this kind and for illustrations of such electrical apparatus as large dynamos and Weston voltmeters. To us this new edition is a disappointment. The mathematical theory is but an abstract of the more elementary part, useless alike to the ignorant and the learned. The accounts of experiments are few, and not of the most recent or interesting. The few pieces of apparatus illustrated are so well known that they might have been omitted without loss. The book at least leaves the ground clean for another and a better on electrical experiments.

AMERICAN COMPETITION IN ENGLISH TRADES.

It is about time that this subject was boycotted by the engineering and other British papers, for until the Press will put an end to giving free advertisement to American millionaires, and their employés, there will be an unending supply of articles of more or less doubtful value.

Great Britain has never expected to hold a monopoly of all the engineering and iron and steel trades of the world, nor that of electrical manufactures.

From the tone of the numerous articles appearing in the Press, it would appear that when any other country finds that it can manufacture a part or the whole of its requirements in iron, steel and allied industries, then British producers must feel in a state of collapse.

What would be the state of affairs if we *were* called upon to produce all the iron, steel, engines, tools, electrical machines and accessories now demanded?

An attempt to answer this question is quite beyond our imagination; anyhow, we could not wish for such a condition of affairs.

Great Britain can still hold up its head on account of its industrial supremacy, for it is no sign of failing when younger countries, rapidly developing under exceptional conditions, are able to create demands and provide supplies without having to appeal to the old country for help.

England has no desire to become a monster iron and steel works and engineering shop. As long as our numerous works are fully occupied, and we have ample room and occupation in our colonies for our overflow of population, we may well be satisfied.

As we have before pointed out, England must be a very poor market for any country to bring its engineering produce to, and because Americans, owing to special circumstances, can send locomotives, iron, coal, &c., to English markets, it is evident that they are desirous of so paralysing our trade that they may get the benefit; or else they take some orders at slight, if any, profit, to fill their shops.

When a few American locomotives were accepted in this country some time ago, through English works not being able to supply them quickly enough, the daily and some other papers were filled with doleful paragraphs as to the loss of our trade and the superiority of American engines. The interesting controversy which Sir Alfred Hickman has raised on the subject of foreign rivals and their locomotives will, we hope, tend to cool off some, if not all, of those writers who have made such a bogey of the subject.

The state of panic in the United States, which exists at present, will, we feel safe in predicting, have very serious results in the near future. Everyone in the United States, holding capital, seems only too anxious to put it into the iron and steel trades, and we may well avoid following their example in this country.

It must always be borne in mind that supply must be controlled by demand, and to take as an instance the case of the American locomotives, when the United States workshops are as full of work as the English ones, the preference will be given to the latter's goods, for under the conditions stated the prices will be about the same, while the better quality of English manufacture will be maintained.

At the Iron and Steel Institute May meeting Mr. William Garrett read what appeared to be a very strong paper, on the failings of British manufacturers in rolling mill practice. We cannot afford space to deal with this paper at length, but those who had the opportunity of hearing it at the meeting, or reading it in *Cassier's Magazine*, need not be downhearted.

It is one thing to cater for an existing demand, and another to find a market for products not called for at the time. While Mr. Garrett was reading his paper, showing how backward British manufacturers were, there was an order for 1,000 tons of cotton ties being delivered on the other side of the Atlantic, although the duty on that article in America exceeded £2 per ton.*

The object of Americans in writing papers and articles, telling Britishers how to meet their competitors, and giving goodly advice to manufacturers how to manage their men, &c., has not for its object the rescuing of British industries from dire calamity, but just to keep up the present boom, and try to get us to give up our markets. No doubt we may be sadly affected by the result of this large outlay of capital, and have to be included more or less in the slump which will follow, but the steady-going Britisher will not be the worst hit.

In all the trusts and combines now being formed in the United States there is of necessity a large expenditure of capital, and this has to be provided by the sale of iron, steel, &c. Under these conditions the demand upon their output cannot be so great as to bring in prices that will prevent them offering their wares in such a poor market as this country must be.

We are pleased to be able to make an exception to our previous remarks in favour of a very interesting article on "Britain and Her Competitors in Iron and Steel Making," by Mr. E. Phillips, which appeared in the June issue of the *Engineering Magazine*. He points out how "Royalties, wayleaves, land payments and ground rents, affect unfavourably the cost of steel making," and suggests measures for the reduction of these charges, from which Americans are exempt.

Proceeding, he refers to the high railway charges in this country, and details the advantages of wagons of large capacity, giving a very good illustrative example:—"The powerful Carnegie engines of 127 tons weight, take from the Lake port to Pittsburgh 30 wagons, carrying 50 tons each of ore, 1,500 tons at one time; the tare of these 50 tons trucks is only 15 tons each, the total dead weight being 2,100 tons. If this 1,500 tons was required to be sent, say from Newport to the Blaenavon or Ebbw Vale works some fine morning (and about the same would apply from Cardiff to the Dowlais and Cyfarthfa works) how many 10-ton trucks would be required to take the 1,500 tons, and how many engines would have to be brought out of the sheds to start, one after the other, with this 1,500 tons of ore? It would require 150 trucks, the tare of each being 5 tons. The engines employed could not take right through to works more than 150 tons each of ore in 15 10-ton trucks, so that it would require *ten engines* and 30 men, with a dead weight of ore, trucks, and engines, of about 2,500 tons, to do the conveyance of the 1,500 tons, which is done in America with *one* engine and three men only.

"Consider what the extra wages must be for 27 more men engaged to do the same work, and the extra coal and stores used by 10 engines instead of those required for one engine. The extra time taken to go the longer distance would have to be taken into account.

"This is the kind of thing that goes on (more or less) to ensure dispatch and quantity in all departments from the mine to the mill in America."

A step in the right direction has at last been taken in this country by the Furness Railway Company, who are experimenting with wagons of 40 tons capacity, having a tare of 12 tons 7 cwt., but at present these are only running between the Barrow Docks and the Barrow Hematite Steel Company's works.

Mr. Phillips's reference to "The Question of Difficulty with Men and their Unions," though it may apply at this date, will, with the development of the combination of trades unions in the United States, probably cease to be applicable, as there is little likelihood of American workmen tolerating soldiers being brought out to settle their trade disputes again.

The possibility of a "Reduction in the Cost of Ore and of Freights" follows, and is well worth consideration, but in regard to raising the present maximum of phosphorus content, in imported ore, while it would allow of a reduction in the cost of ore, it must not be overlooked that the *quality* of the steel would be reduced, and the price to be obtained would also be less. The statement that 0·10 per cent. of phosphorus is allowable in steel containing only 0·10 per cent. of carbon if not more than 0·05 per cent. of sulphur be present only applies to the low carbon steels, for steels of higher carbon would be very much deteriorated in quality. Mr. Phillips goes on to say:—"We are informed that the American soft steel will not bear deep stamping, such as British steel will readily do."

No doubt improved facilities at ports of loading and discharge would be of great advantage and would pay well for the outlay, and the means of transport of the ore to the riverside at Bilbao, by ropeways, &c., are a very good instance.

Mr. Phillips says:—"It may be fairly assumed that a mine trust, working their own mines and making improved shipping facilities, after allowing a moderate interest on capital invested, would obtain their ore at from 5s. to 7s. 6d. less than it now costs them, which would mean 10s. to 15s. per ton of steel."

In dealing with the saving in the price of coke, we think that too

* Mr. Bleckly, I. & S. Institute meeting, May, 1901.

much is made of the recovery of bye-products; the more coke ovens there are put down equipped with the necessary apparatus for recovering the ammonia, &c., the lower will the value of the products fall, until the application becomes in some cases hardly worth the expense of the outlay, though when this is combined with the utilisation of the gases in gas engines for power purposes, along with blast furnace gas, a considerable economy may be effected.

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING JULY 24TH, 1900.

Alexandria	Value £104
Azores. Teleg. cable ..	166,000
Bangkok	148
Boca. Teleg. mat.	197
Bombay	230
Buenos Ayres	1,769
,, Teleg. mat. ..	452
Calais	45
Calcutta	805
,, Teleg. wire	182
Cape Town	212
Christiania. Teleg. wire ..	39
Christiansand. Teleg. cable ..	63
Colombo	75
Copenhagen. Teleg. wire ..	161
Durban	238
Gibraltar	78
Hamburg	24
,, Teleg. mat.	350
Hong Kong. Teleg. mat. ..	51
Launceston	145
Melbourne	38
Ostend	300
Rio Janeiro. Teleg. mat. ..	682
Rotterdam. Teleg. mat. ..	150
Singapore. Teleg. cable ..	12,060
,, Teleg. mat.	357
Sydney	295
,, Teleg. mat.	174
Wellington. Teleg. cable ..	120
,, Teleph. mat. ..	2,261
Yokohama	475
Total ..	£188 220

WEEK ENDING JULY 23RD, 1901.

Alexandria	Value £2,730
Amsterdam	75
Barcelona	73
Bombay	71
,, Teleg mat.	329
Brisbane	497
Buenos Ayres. Teleph. fittings	650
Calcutta	1,033
,, Teleg. wire	87
Cape Town	421
Christchurch	20
Christiania. Teleg. wire ..	10
Colombo	20
Constantinople. Teleg. cable ..	604
Copenhagen	18
,, Teleg. wire ..	17
Demerara	480
Durban	713
,, Telep. apparatus ..	104
Fremantle	60
Genoa. Teleg. wire	15
Gibraltar	91
Hamburg. Teleg. mat. ..	228
Lisbon	116
Port Elizabeth	680
Quebec	29
Rotterdam	60
,, Teleg. mat. ..	314
St. Petersburg. Teleg. cable ..	56
Shanghai	156
Singapore	53
Stockholm. Teleg wire ..	50
,, Teleph. cable ..	104
Sydney	581
Tokio	18
Wellington	174
Yokohama	101
Total ..	£10,807

Foreign Goods Transhipped.

Brisbane. Teleg. apprts.	Value £49
Gothenburg. Elect. apparatus	18
Total ..	£67

Amendments of Patents.—W. L. Voelker, of 38, Bernard Street, Russell Square, London, has applied for leave to amend the Specification of Letters Patent, No. 20,346 of 1899, granted to him for "Improvements in the manufacture of incandescing electric lamps."

T. C. Crawford, of New York City, has also applied for leave to amend the Specification of Letters Patent No. 6,149 of 1899, granted to W. L. Voelker, for "Improvements in the manufacture of filaments for incandescing electric lamps, and in means applicable for use in such manufacture."

American Vitrified Conduit.—We have received from Messrs. Maguire & Baucus, of 5, Warwick Court, their catalogue of American vitrified conduit for cable ways. Vitrified conduit is salt glazed clay or earthenware of cellular construction, made from stoneware clay, fireclay and spar well mixed and ground. Undoubtedly a thoroughly burned or vitrified piece of earthenware is one of the most durable of artificial substances. The millions of Roman bricks and tiles still existent in this country are conclusive evidence of this. The usual dimensions of conduit are 2 to 4 ft. Each length is made with pin holes in its ends, so as to hold dowell pins to enable complete alignment to be effected. In shape the cross-section may be circular, or square with rounded corners. The ends are roughened, and when put together are wrapped with a 6 in. strip of asphalted burlap or damp cheese clother, and a coat of cement-mortar is rendered over. The cost of each duct installed per foot run varies from 1s. 8d. for the single ducts down to 7½d. per duct where 35 ducts are run together. Any number of ducts can be run in a cluster, the space occupied by 72 ducts being 42 in. × 39 in. when laid, and that of two ducts being 9 × 12. When necessary the whole bank of conduits may be enveloped in an outer casing of concrete. Being in short lengths, the conduit can be laid round any reasonable curve. Glazed conduit has a smooth interior which offers small resistance to drawing in; it is fireproof, acidproof, gas and waterproof, and is a sure protection against short circuiting and grounding.

Annual Outings.—The staff, employés and friends of Messrs. Rawlings Bros., Limited, engineers, of Kensington, Belgravia, Blackheath and Chiswick, went for their annual summer outing to Clewer, near Windsor, on Saturday, July 13th. The invitations numbered nearly 200. Luncheon and tea were served under canvas on the banks of the river. There was an excellent programme of sports carried out under the direction of Mr. F. Rawlings.

On Saturday, July 20th, the staff of the British Thomson-Houston Company, Limited, had their annual outing, which this year took the form of a sail on the picturesque Thames from Maidenhead to Henley. The size of the gathering necessitated the chartering of the largest launch on the river, the *England*. At the Red Lion, Henley, a bountiful banquet was presided over by the genial managing director, Mr. W. J. Clark. In the cool of the evening, the *England* slipped down the river towards Maidenhead, tea being served on board.

The employés of the Liverpool Tramway Carriage Works held their annual picnic on Saturday last. After visiting places of interest at Rhyl, dinner was served at the Grosvenor Hotel. Afterwards, the company drove to Boddelwyddan and St. Asaph, and on their return had tea at the hotel.

Battery Makers to His Majesty.—The E.P.S. Co. have been appointed makers of secondary batteries to his Majesty the King. The company also held a similar warrant from the late Queen.

Books Received.—"Electricity in Mining," by H. Louis. London: The *Mining Journal* 1901. 3s. net.

"Galvanoplastie et Galvanostégie," by Ad. Minet. Paris: Gauthier-Villars, 1901. 3 frs.

Catalogues and Lists.—The International Electrical Engineering Company, of Clun House, E.C., send us copies of their price lists of entirely enclosed continuous current motors, and special quality arc lamp carbons (Mark C.I.E. electron, and Mark C.I.E.) as made in their re-modelled Liège factory. We have also received a number of good photo prints showing the wide range covered by the company's manufactures, these including, as is well known, dynamo machinery, polyphase plant, cranes, hoists, controllers, apparatus, locomotives, and so on. One of these prints illustrates one of three 1,000-KW. direct current dynamos supplied to Brussels central station, and one shows a 125-KW. generator driven by a Willans engine.

Messrs. Pirelli & Co., of Milan, have issued an illustrated catalogue of the cables which they manufacture for very high voltages. A certificate of test made by Prof. L. Zunini, of Milan, in April last on a three-phase 25,000-volt cable is printed. We learn that the company is expanding its business with foreign countries, and claims to be supplying cables to the British Colonies.

The Delta Metal Company, Limited, are circulating lists bearing on Dick's patent extruded screwing brass for use on automatic screwing machines, capstan lathes, &c.; also their white anti-friction metal.

The Berliner Telephone Manufacturing Company have brought out a coloured wall sheet of their "Twentieth Century Telephones."

We have received from the General Electric Company (1900), Limited, a copy of the second edition of their list of "Geeko" telephones. These are of British manufacture, and the bell push telephones can be added to any existing electric bell service. The list contains several novelties.

Messrs. John Spencer, Limited, of Wednesbury, have issued a July card of discounts for tubes and fittings. They have also sent us a list of odd size tubes which they have in stock.

Dissolutions and Liquidations.—A meeting of the World Gas and Electric Syndicate will be held on August 30th, at 27, Broad Street Avenue, to hear an account of the winding-up from the liquidator (Mr. C. S. Kelman).

A similar meeting of the Electric Light Insurance and Maintenance Company is announced for August 27th, at 100, St. Martin's Lane, W.C. Liquidator, Mr. G. E. Bunbury.

Messrs. A. F. R. Curteis and C. P. Wooler (Curteis & Wooler, electrical engineers, 66, Victoria Street, S.W.) have dissolved partnership. Mr. Wooler attends to debts.

Messrs. Cecil Wray & Co., Limited, of Bradford, are winding-up voluntarily. Mr. W. C. Atkinson, 10, East Parade, Leeds, is liquidator.

Creditors of the Electrical Inventions and Manufacturing Company (in liquidation) must send particulars of debts to the liquidator (Mr. C. W. Provis, jun., 3, Mount Street, Manchester) by August 15th.

Creditors of the Electric Street Car Manufacturing Syndicate, Limited, must send particulars of debts, &c., to Mr. W. Fletcher, 47, Lichfield Street, Wolverhampton, the liquidator, by August 31st.

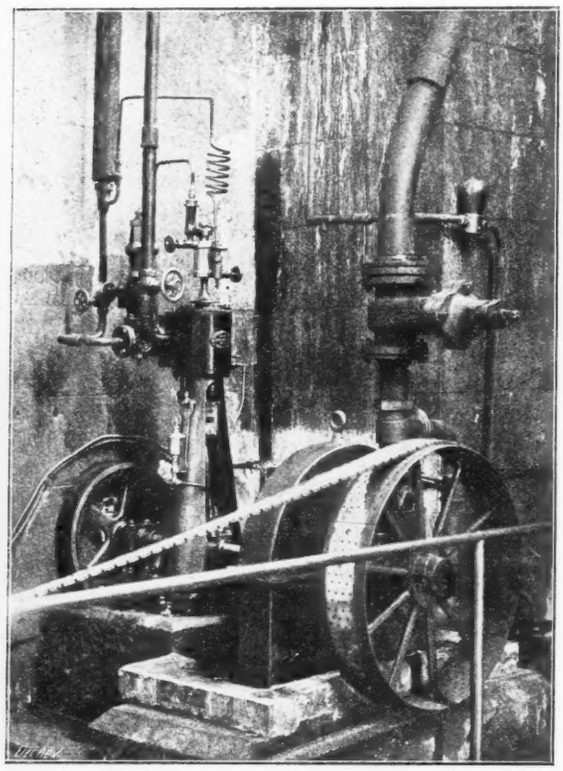
For Sale.—A Manchester dynamo, Brockie-Pell arc lamps, switchboard, &c., are for sale at the Mullingar District Asylum. See our "Official Notices" to-day.

Holidays.—The Langdon-Davies Electric Motor Company, Limited, notify that their works and offices will be closed from Saturday, August 3rd, to August 10th. Urgent correspondence will, of course, be dealt with during that period.

The G. E. Railway has issued through its publishers (30, Fleet Street, E.C.), a little illustrated circular, "A Channel Fleet," describing the company's steamers and services in connection with the Harwich—Hook of Holland route to the Continent.

The Plant at Walker Power Station.—We have received the following letter from Manchester:—"We notice in your issue of July 12th, in describing the Wallsend Slipway and Engineering Company, Limited's, engine constructed for the Walker power station, that you mention this engine as being controlled by 'a chain-driven governor of the Proell type.' This is a misstatement, and calculated to do us possible harm. We shall feel greatly obliged, therefore, if you will be good enough to insert a correction in your next issue stating that the governor controlling the engine is Whitehead's patent isochronous governor.—E. G. COCKRELL & Co., sole agents for the patentee."

Hydro-Steam-Electric Plant.—We illustrate below a high-speed steam engine combined with a Pelton water-wheel which was recently supplied to the Chester Water Works Company by Mr. P. Pitman, of Halifax. The company employs the plant for driving dynamos for lighting the pumping station and filter beds, the arrangement being that either the Pelton wheel or steam engine can be run separately or combined, as required. The wheel is 3 ft. in diameter, fitted with phosphor-bronze buckets, the sides of the buckets being widened out to allow the spreading of the water as its velocity diminishes. The main shaft is fitted with stuffing oxes, which prevent the lubricating oil from mixing with the water, special attention being given to this important point, as the



water is subsequently filtered, and passes into the town mains Two ⅞-in. nozzles are fitted to the wheel, but only one of these is generally required. The installation is somewhat similar to that put in at the Lynton and Lynmouth Company's electricity works, where Pelton wheels and turbines are used alternately, the steam engine in this latter case being used in cases of emergency only. Mr. Pitman has sent us lists of his "Hector" water motor and hydraulic bottle washer.

Private Installation Work.—The National Electric Wiring Company has secured the order for a complete electric lighting installation for "Broadlands," Romsey, Hants., for the Rt. Hon. Evelyn Ashley; also for the lighting of the Grand Hotel, Llandudno, and on the Ocker Hill power station for the Midland Electric Power Distribution, Limited, of Liverpool, and a large order from the War Office.

Robertson Lamps.—Among recent orders received by the General Electric Company for these lamps is one for a further 300 for use on H.M. yacht (being installed through Messrs. Waring and Gillow), and one for 600 for Lord Salisbury's house at Hatfield. A further 2,000 were recently ordered by the Midland Railway Company, and 6,000 are to be supplied to the Bradford Corporation in connection with the change over. The demand has continued to increase since the extension of the Brook Green factory.

Summons Dismissed.—At West London, Mr. Lane, K.C., resumed the hearing of an adjourned summons against Arthur Barrett, a shopkeeper, of High Street, Kensington, at the instance of the Postmaster-General in respect of a dispute which had arisen in laying down pipes and wires in front of the defendant's premises in connection with the new telephonic system in the metropolis. Mr. Lane, K.C., dismissed the summons, holding that the place was not proved to be a street. He allowed agreed costs.

Trade Announcements.—The European MaGuire Manufacturing Company, Limited, of London, has just purchased the Elton Fold Works, at Bury, Lancashire. The property comprises about five acres, and there is about 25,000 yards of floor space under cover. The company will begin immediately to equip the factory, and it is stated that within three months all orders for trucks will be filled at the factory, and the goods made there. Messrs. MaGuire & Baucus, of 5, Warwick Court, High Holborn, W.C., are the selling agents for the output of the factory.

Messrs. Warren, Beattie & Co., of Middlesbrough-on-Tees, have taken into partnership Mr. Chas. Bertram (formerly manager to Messrs. D. Selby Bigge & Co., of Newcastle), and for convenience the company has been registered under the Limited Liability Companies' Act, and will henceforth be known as Warren, Beattie & Co., Limited. Mr. J. W. F. Warren and Mr. C. Bertram will act as managing directors to the company, and Mr. Jos. Beattie as director and secretary. John Beattie, Esq., J.P., Mayor of Newcastle-upon-Tyne, is to be chairman to the company, and Mr. S. N. Warren, who has taken an active part in the business, has also been elected a director.

ELECTRIC LIGHT AND POWER NOTES.

Australia.—Messrs. Trackson Brothers have recently installed electric lighting and power plant for the extensive meat works of Messrs. Birt & Co., at Mooraree. A 130-H.P. high-speed Browett-Lindley self-lubricating engine drives a 100-KW. (200-volt) Laurence-Scott dynamo. The motors include two 10-H.P., three 5-H.P., four 3-H.P., and these are to be added to. The fans are to be operated by motors of from 2 to 8 H.P. About a mile from the works there is an electrically-driven pump, which delivers 30,000 gallons per hour. For the lighting there are 300 incandescents and six 2,000-C.P. arcs.

Bournemouth.—The Bournemouth and Poole Electricity Supply Company have withdrawn from the negotiations with the T.C. for the purchase of their undertaking.

Brechin.—The electricity works, which have been erected by a local company (the Angus Electric Light and Power Company), with the assistance of Edmundson's Electricity Corporation, are now completed. They are situated on the Granary Road, and have a railway siding. The works consist of a boiler house, engine and dynamo room, accumulator room, workshops and offices. The boiler house contains two Babcock & Wilcox boilers. There are also two Worthington pumps and a Wright feed-water-heater. In the engine room the engines and dynamos are of the Belliss-Parker direct-coupled type. The balancer and booster set are also of Parker's make. The switchboard is of Edmundson's well-known type, made by Mr. Edmund Charrington, and the instruments used are Lord Kelvin's. The accumulators, which are on two flats, are made by the D.P. Company. The cables have all been supplied and laid by Callender's Cable Company. The station is on the three-wire system, and boosters are used for charging the battery. The accumulators can be turned on direct to the town's supply, thus doing away with the necessity of running the works during the night. Exclusive of the public lighting there are already about 1,500 8-C.P. lamps wired, the supply of which was turned on a fortnight ago. Wherever the cables are laid the streets will be lit by incandescent electric lamps. The company have carried out free wiring arrangements. The buildings have cost about £3,000, while the sum spent on the whole undertaking will probably total £25,000.

Brighton.—The T.C. has adopted the recommendation of a committee that the surveyor prepare specifications upon which tenders may be invited for installing the electric light in the rooms in the Pavilion in which it has been decided to substitute electric light for gas at an estimated cost of £455 10s.

Bristol.—Electricity is now employed for driving the printing machinery by which the *Bristol Mercury* is produced. Two 35-H.P. motors drive the Foster & Hoe printing machines, and another drives the Linotype machines.

Cleckheaton.—The Electricity and Destructor Committee recently referred all the tenders for the supply of electrical machinery for the Council's new works to Messrs. Gibbings & Baker, engineers, for their report. A sub-committee has been appointed to visit various towns which have similar works in operation.

Croydon.—The R.D.C. has received notice from the Surrey Electric Power Distribution Company of their intention to apply for a provisional order for the district.

Dublin.—Electric lighting contracts came up for consideration on Monday amounting to about £56,000; these we refer to in our "Contracts Closed" to-day. Mr. Irwin, the chairman of the Electric Lighting Committee, has proposed that the present constitution of the Committee should be changed, and that other members of the Council should be appointed to take the places of those who are avowedly hostile to the city enterprises in the matter.

Exeter.—The E.L. Committee last week considered an analysis of the tenders for electrical works and plant drawn up by Mr. H. D. Munro, city electrical engineer, and resolved to recom-

mend the Council to submit the scheme of the electrical engineer, alternative plans, and the tenders received to an expert, who shall advise whether sectional tenders should be accepted, or one tender for the execution of the whole of the work. It was also resolved that the president of the Institution of Electrical Engineers be asked to submit the names of three persons to advise the Council in the matter. Fourteen tenders have been received for the electricity station buildings, the lowest being £13,903, and the highest £27,096. All the principal electrical firms have tendered for the plant and equipment, which for single-phase and two-phase supply on the alternating current principle, can be obtained, in the judgment of Mr. Munro, for £24,000 or £25,000, making a total estimated cost for buildings and plant complete of about £40,000.

Gravesend.—The E.L. Committee has secured a site for electric light and destructor works. It has been decided that the charge to the tramway company for energy between 180,000 and 400,000 units per annum shall be 1¼d. per unit. Mr. Trentham has been instructed to have specifications for the station, &c., printed.

Halifax.—The accounts of the Corporation electricity works for the year ending March 31st last were issued on Tuesday last. The year's expenditure on capital account is £46,798, making a gross expenditure since the commencement of £137,884. During the year there has been expended on mains and services £19,236, on meters £1,131, on transformers and motors £1,087, electrical instruments £106, and on machinery £18,907. The revenue account shows net income, including £10,238 13s. for electricity supplied to tramways, £19,081 11s. 9d., and there is a balance profit of £4,339 16s. 11d.

Huddersfield.—The Corporation electricity department has at present 1,432 consumers of electricity for lighting purposes, &c., with 92,607 lamps connected.

The Corporation has resolved to apply to the L.G.B. for sanction to borrow £100,000 for machinery, mains, &c., required for the further supply of electricity for lighting purposes.

India.—*Indian Engineering* says that Major Stuart, R.E., Inspector of Submarine Defences, will probably be employed at Simla in helping the Military Works Department in the preparation of electrical installation projects, and it is not unlikely that an Engineer officer will also be sent from home, as the work is getting very heavy.

Isle of Thanet.—Messrs. Medhurst & Lloyd have recently drawn up a scheme for the Joint Hospital Board for lighting the hospital by electricity.

Leith.—At a special meeting of the T.C. last week electric supply accounts were shown for the period from December 31st, 1900, to May 15th, 1901, and over that they showed a deficit of £576 8s. 7d. It was hoped that by this time the electric undertaking would have been meeting all charges, and in a fair way of having a surplus to repay sums already charged against the police account, but owing to the high price of coal and the heavy sums chargeable for payment of loans and interest thereon, these hopes have been disappointed. It was stated that the only satisfaction that could be found in the accounts was the fact that £2,491 10s. 8d. of borrowed money had been repaid, and to that extent the undertaking might be said to be owned by the ratepayers, but most ratepayers would consider this very small satisfaction, and would much prefer not to have surpluses which were really made up out of taxation. In considering the whole accounts of the burgh, the electric lighting supply account was the only one in regard to which there needed to be any concern. Discussion of the accounts was postponed till September. The Council then rose.

London, E.C.—At the last meeting of the Court of Common Council a letter was read from the City of London Electric Lighting Company as to the decision of the Court of Appeal, declaring that their contracts with the Corporation in respect of the Central and Western districts of the City were null and void. They suggested a conference, but the Streets Committee's recommendation as to the undesirability of the conference, and stating that they were prepared to give every consideration to any proposals the company might choose to submit in writing, was agreed to.

Marylebone.—The Board of Guardians have resolved to instal electric light plant and new boilers at the Rackham Street Infirmary. Mr. T. W. Baker's No. 2 scheme (capital outlay, £9,039, annual cost of maintenance, £1,083) has been adopted.

Long Eaton.—The 38 tenders for the electric light scheme are to be submitted to Mr. Crowther, of Wallasey, the consulting engineer to the Council.

Mansfield.—The Midland Railway Company has informed the T.C. that the cost of constructing a siding at the proposed electric light station in Rock Valley is estimated at £5,145, and the annual expense in wages would be £185. A letter was read from Messrs. Milward & Co. stating that the tramway company would require a supply of electrical energy in the early part of July next year.

Merthyr.—The surveyor recommends the Council to light the public streets by electric arc and incandescent lamps. Representatives from the Merthyr Electric Light and Traction Company have also been before the Council with several proposed schemes for electric lighting. The whole matter was eventually deferred.

Mitcham.—The B. of T. have granted an electric lighting order for the district.

Norwich.—The Committee recommends the employment of an electrical engineer and expert to advise it in carrying out the purchase of the electric light company's undertaking.

Rochdale.—It is stated that the substitution of Mond gas for coal fuel at the electricity works has been considered, but a committee has reported against the change.

Romsey.—The National Electric Wiring Company has been in communication with the T.C. inquiring the attitude that would be assumed if the company were to assist in the formation of an electric lighting company for the district.

Salford.—A town's meeting deputation waited upon the Mayor the other day with reference to certain allegations which have been made about the management of the new electric generating station at Strawberry Hill. A public inquiry has been asked for.

Southampton.—The Corporation has appealed against the assessment of the electric light works. The hearing has been postponed until the October Sessions.

Woking.—The T.C. wished to break with the Electric Light Company for the public lighting and have gas lighting, but before being legally off with the old love, it was on with the new, under a seven years' contract. It wanted the Electric Light Company's pillars for the accommodation of the Gas Company, and the company told it to take them. The Council, however, didn't like to interfere with the electrical connections. After a good deal of time elapsed through these negotiations, it was brought home to the Council that under the agreement with the Electric Light Company, a three months' notice to terminate the contract had to be given on July 7th to expire on October 7th. It is hardly possible for the pillars to be used for electric and gas lighting at one and the same time.

ELECTRIC TRACTION NOTES.

Birkenhead.—Another new electric tram route, known as the Woodside—Conway Street route, has been completed at Birkenhead. Trial runs have been made on the line, and it will, in the ordinary course, be opened for traffic in a few days.

Blackpool.—The Blackpool Tramways (South) Company, Limited, has been formed to take over the present line of tramways between Blackpool and Lytham; to convert the line into an electrical one, and to extend it to Preston. An order for the extension will be applied for. Mr. J. Fell, Westminster, estimates that the profits from the electrical line between Blackpool and Lytham will be £21,645 per annum, and from the extended line, £35,866.

Bournemouth.—At the T.C. meeting last week the surveyor was instructed to prepare a report on the properties he considers should be taken for street widening. The deputation that visited Brussels recommended the adoption of the conduit system. The engineer's report on this, which we have already briefly abstracted in the Electrical Review, was considered. Messrs. Lacey, Clirehugh & Sillar advised the Council that it might safely be adopted, but recommended that it should be confined to the centre portion of the line, and that the extremities, where the roads were wider and there was less shop property, should be, as proposed, on the overhead plan. They pointed out that the extra cost per mile would be £6,000, which would mean £50,000 for the full main route. The conduit system for the centre length only would not exceed £15,000, and the use of the overhead system for the remainder of the lines would effect a saving of £35,000. With regard to whether the conduit slot should be in the centre of the track or whether the rail slot system should be adopted, the engineers reported that it was difficult to decide, as they had not yet ascertained what position the Board of Trade might take up. The rail slot conduit was cheaper in cost of construction, and better for traffic, especially on inclines, as there would be less iron on the roads. The additional cost if their suggestions were agreed to would be £15,000 for the length of conduit, £450 for return insulated cable, £2,100 for additional switchboard and alterations at generating station, and £2,800 for plough attachment and equipment to cars at £100 per car, a total of £20,350. The additional cost of maintenance would be about £300 a year. This would not cripple the scheme financially, and would remove many objections. The report was adopted without any discussion.

Cheltenham.—Mr. Nevins, the electrical engineer, who has just completed an extensive electric railway scheme at Cheltenham and who proposes to undertake similar work at Stroud, invited the members of the Stroud Urban Council to visit Cheltenham to see the railway in working order. The invitation was accepted, and on Tuesday afternoon the Stroud Councillors journeyed to Cheltenham, where a pleasant and instructive time was spent, the party returning home delighted with the railway. There is little doubt now, says our local correspondent, that Stroud will have its railway, and that the local authority will place no obstacle in the way of the project.

Glasgow.—The recent breakdown of one of the rotary converters at Dalhousie station has now been found to have been caused by allowing the rocker holding the carbon brushes to revolve some 2 in. out of the correct position for full load. Sparking started and gradually increased till the spark leapt across to the frame of the machine. A pointer and indicator has now been fitted to all the machines showing the range of lead allowable.

At a meeting of Paisley Town Council on the 9th inst. the following minute was read:—"The deputation, by their chairman, stated they had come before the Committee to ask their consent for the construction by Glasgow of the tramway line between the burgh boundary and Hawkhead Road. After discussion, terms mutually satisfactory were provisionally agreed to." This means that Glasgow and Paisley (some 9 miles distant) will now be joined by an electric car system.

Another record has been made in traffic receipts. The amount taken for the week ending July 13th reaches the total of £12,952 4s. 1d., compared with £9,855 9s. 1d. for the same period last year, or £598 6s. 3d. better than the previous record. Since the inauguration of the electric system traffic receipts have gone up. Since the beginning of the present financial year, June 1st, the receipts amount to £74,582 5s. 9d., an increase of £12,523 13s. 2d. on the same period last year. Probably 50 per cent. of this increase may be accounted for by the traffic to and from the Exhibition.

Halifax.—Twelve new tramcars have this week been added to the Halifax Corporation system, making a total of 70. Each car is fitted with Spencer's patent slipper brake.

Hampton.—It is reported that the London United Tramways, Limited, have acceded to the wishes of the U.D.C. for the widening of the roadways in their district to the full statutory width for the company's light railway scheme. The company will spend about £30,000 for this purpose.

Hendon.—The Hendon Tramways Bill was read a second time in the Commons on 19th inst.

Huddersfield.—For the three months ended June 30th, 1901, the receipts from the Corporation tramways amounted to £11,465 6s. 10d., viz., electric, £6,288 9s. 2d., steam power, £5,176 17s. 8d., leaving a net deficiency of £546 14s. 5d. on electric cars, and £1,434 3s. 1d. on steam cars, after allowing for interest and sinking fund, £2,861 19s. 11d. and £1,317 17s. 1d. respectively. For the month of June the receipts were (steam) £1,829 8s. 1d., or 13·31d per mile (miles run, 31,822), and (electric) £2,226 6s. 1d., or 10·57d. per mile (miles run, 50,263). It was stated that last year the steam cars cost 18½d. per mile run, or a loss of 4½d. per mile. For the three months, ended June 30th last, there was a deficiency in both systems of £1,980 17s. 6d., but a substantial part of this sum, if not the whole, will be transferred to capital account. The wages for the past year on the steam sections amounted to 5·8d. per mile run, whereas in Glasgow the total expense of the whole system, including wages, fuel, maintenance, &c., was only 6·32d. per mile, so that Huddersfield was paying for wages alone within ½d. per mile of the total cost of the Glasgow working expenses.

The Corporation have appointed Mr. Harry Barron, Manchester, shift engineer.

Italy.—The projected electric railway between Rome and Naples has been approved. The journey between the two cities will be reduced to one of three hours.

Kingston-on-Thames.—At a special meeting of the T.C. it was agreed to seal the supplementary agreement of the London United Tramways, Limited, for the widening of a part of the Surbiton Road, subsequent upon a decision of the House of Commons Committee. It was also decided to present a petition to the House of Lords against alterations in the company's Bill as amended. Regret was expressed that the Surrey C.C. had not been successful in retaining the clause by which they sought power to purchase the Surrey tramways, failing the willingness of the local authorities to take over the lines. Kingston is thus the only authority in the district which will be able to purchase the undertaking under the Tramway Act in 25 years' time.

Metropolitan Railway and Electric Traction.—In their report for the half-year ended June 30th the directors state that there is a profit of £203,376. The receipts show a decrease of £32,742 and the expenses an increase of £7,359 as compared with the corresponding half-year of 1900. The falling off in the receipts is attributable entirely to the competition of the Central London Railway, which—owing largely no doubt to the low fare charged by that company—caused a loss of traffic in the half-year of about £42,000, a sum equal to £1 9s. 4d. per cent. per annum on the consolidated ordinary stock. The directors tell the shareholders in some detail the story of the electric conversion negotiations and delays which have given rise to so much discussion of late. They state that proprietors will remember that in the report issued in January last it was stated that nine tenders had been received and reported upon by Sir W. H. Preece and Mr. Thomas Parker, the electrical engineers of the Metropolitan and District Companies, and that those gentlemen had been requested to make a thorough examination of the system proposed by one of the firms. The engineers having reported that this system, which was that of Messrs. Ganz and Co., of Buda-Pesth, stood out from all the rest by reason of its economy and combined efficiency and simplicity, both in installation and working, the joint committee of the two companies despatched the engineers to Buda-Pesth in order that they might make a thorough and exhaustive examination of the system in actual work. After a complete examination of the system both the engineers sum up its advantages by stating that "it is a decided step in advance of any other system in use in the United Kingdom or in America, and is eminently adapted to facilitate the application of electric traction upon our principal railways." The joint committee at a meeting held on February 7th, 1901, having considered the report, passed a resolution to the effect that the system proposed by Messrs. Ganz & Co. is the one best adapted to meet the requirements of the Inner Circle service. The directors state that the board of the Metropolitan Company on February 13th adopted the view of the joint committee, and a letter was subsequently written to Messrs. Ganz & Co. by the two companies informing them that the boards of the companies had carefully considered the question and viewed with favour the proposals contained in their tender, subject to the approval of the Board of Trade of the method of working proposed, and to certain other conditions which the engineers might deem necessary. The board go on to say:—"It was therefore a matter of surprise to your directors that the District Company, without consultation with your board, shortly afterwards announced their determination to electrify their railway upon an entirely different system. To enable this to be carried out the District Company sought Parliamentary powers to compel the traffic of other companies passing over the District Railway to be worked by the particular system adopted by that company. Your board considered such enactments prejudicial to your interests, and petitioned against them, with the result that a clause has been inserted in the District Company's Bill to the effect that, unless within one month after the passing of the Act the Metropolitan and District Companies shall have agreed to adopt the same system for the working by electrical power of the portions of their respective railways forming part of the Inner Circle railway and also the City lines and extensions, either company may refer the question to the Board of Trade to appoint a special tribunal to hear evidence and report to the Board of Trade, who are thereupon directed to determine which system of electrical working shall be adopted."

Middlesex.—On 18th inst. Mr. Hopwood, Permanent Secretary of the Board of Trade, heard an appeal of the Finchley U.D.C. against the confirmation of an order of the Light Railway Commissioners giving the County of Middlesex power to make light railways over the Great North Road. Mr. Wedderburn, K.C., for the Finchley Council, stated that the Light Railway Commissioners had before them two schemes, one promoted by the Finchley Council, and the other by the Middlesex County Council, and, without hearing the Finchley Council, decided that the County Council's scheme should be carried out. He submitted that the Light Railway Commissioners had no power to decide without hearing the Finchley authorities on the scheme within their own boundaries, and that it was never intended by the Light Railway Act that the Commissioners should have such power of deciding against the local authority through whose district the railway proposed to run. The matter should have gone before Parliament. Mr. Cripps, K.C., contended it was within the jurisdiction of the Commissioners, and therefore the Board of Trade should confirm the order. Mr. Hopwood said the matter was very important, and would be fully considered by the Board.

Mitcham.—The Croydon District Council have approved of the draft of the light railways order for Mitcham, but the local gas and water companies are making an effort to get protective clauses. The Mitcham Parish Council have also approved of the draft order.

Nottingham.—Major Pringle, R.E., one of the inspectors of the Board of Trade, visited Nottingham last week and inspected the route of the electric tramways between Bulwell and the Great Market Place. It is understood that the inspector's report will be quite satisfactory, and that there will be no difficulty in commencing the running as soon as the number of cars necessary for the working of the line have been delivered and tested.

Oldham.—On Friday last Major Druitt made a B. of T. inspection of the Hollins Road section, 1¾ miles, of the electric trams. It is stated that Messrs. Hewitt & Rhodes, the consulting engineers, have designed a special form of slipper brake which has been applied, pulling cars up instantaneously within their own length on a gradient of 1 in 12 when running at 8 or 10 miles an hour.

Perth.—The T.C. has received a letter from the secretary of the Perth and District Tramways Company, Limited, stating that they were not prepared to entertain the offer of £20,000 by the Council for their undertaking.

Sunderland.—During the prevalence of the thunderstorm at Sunderland on Friday night a somewhat curious accident occurred. One of the pillars carrying the overhead wires was struck, and the cable which it carries from the switchbox to the overhead wire was at once ignited. The cable, which was, of course, insulated, burned brightly, and the flame was in some way communicated to the switch box. So fierce was the fire that the pillar became red-hot, but very quickly the fire died down and all danger was at end. It was found necessary to join the section in which the accident happened to the adjoining section, and with this arrangement the service was resumed and satisfactorily maintained until effectual repairs were made. No one was in the slightest way affected by the accident, and the delay to traffic was small.

Whitstable—Herne Bay.—An inquiry is to be held by the Light Railway Commissioners at the Guildhall, Canterbury, on August 1st, with reference to the Whitstable and Herne Bay Light Railway scheme.

(Continued on page 154.)

LONDON UNITED TRAMWAYS.

(*Continued from page* 91.)

The company's headquarters are situated in High Road, Chiswick, W. Within their extensive property, covering an area of 4 acres, the company have erected a model power station. The depôt is shaped like the letter Y, with the narrow end to High Road, and at the left-hand side of the entrance the attention of the visitor is at once attracted by the pleasing architectural features of the long range of administrative offices, within which rooms are provided for the managing director and engineer and his staff, the board room, the offices for the traffic superintendent of the line, the inspecting staff, reading rooms and other accommodation for the out-door staff, and apartments for all the various subordinate departments of the administration. Beyond these, and facing the entrance, are seen the commodious car sheds, of which particulars are to be given later.

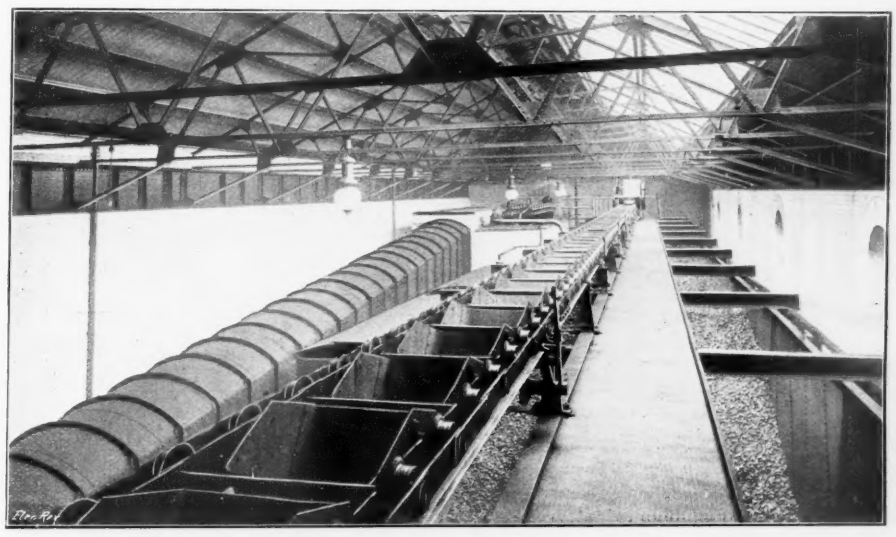
Outside View of Power House

To the right of the space facing the car sheds, is seen the splendid building within which the electric power for the entire system, existing and proposed, is generated. This handsome power house is built of brick, with massive freestone quoins and other adornments. To the courtyard it presents a façade of 154 ft., showing a circular-headed doorway in projecting wings at each end, with three large windows of similar design within the slightly-recessed centre. A bold cornice in freestone traverses the building above these openings at a height of 47 ft. from the ground, the wings being carried up in stone above this cornice to a final height of 79 ft., while variety is given by the recessed centre, where the brick structure is partly continued till the line is broken by two large circular shields of freestone, the tops of these breaking the rigid lines of the stone coping. This frontage is decoratively treated at various points with sculpture, &c., and may claim to be the finest structure devoted to the same use in this country.

The building has a total depth of 106 ft., and is divided internally into two main portions—the engine room and boiler room. The internal walls of both these divisions are faced with glazed bricks, and the engine room floor is laid with mosaic tiles.

The boiler room, which occupies the eastern portion of the building, consists mainly of steel frame structure, designed to carry the heavy weights of the coal storage bunkers (which contain 500 tons of coal), the flue, the economiser, and the feed-water tanks, all of which are located on a floor above the boilers. This steel structure extends to the roof, thus making the boiler room practically independent of the engine room. The steel work was carried out by Messrs. Barry & Higham.

The equipment in the boiler room consists of 10 Babcock & Wilcox water-tube boilers, each capable of evaporating 11,000 lbs. of water per hour at a steam pressure of 150 lbs. per sq. in., with a draft as measured in the main flue equivalent to a column of water $\frac{3}{4}$ in. in height. The total heating surface in each boiler is 3,140 sq. ft. The boilers are arranged in five batteries; each boiler is fired by a mechanical stoker of the "coking" type, and these stokers are driven by shafting placed underneath the floor.

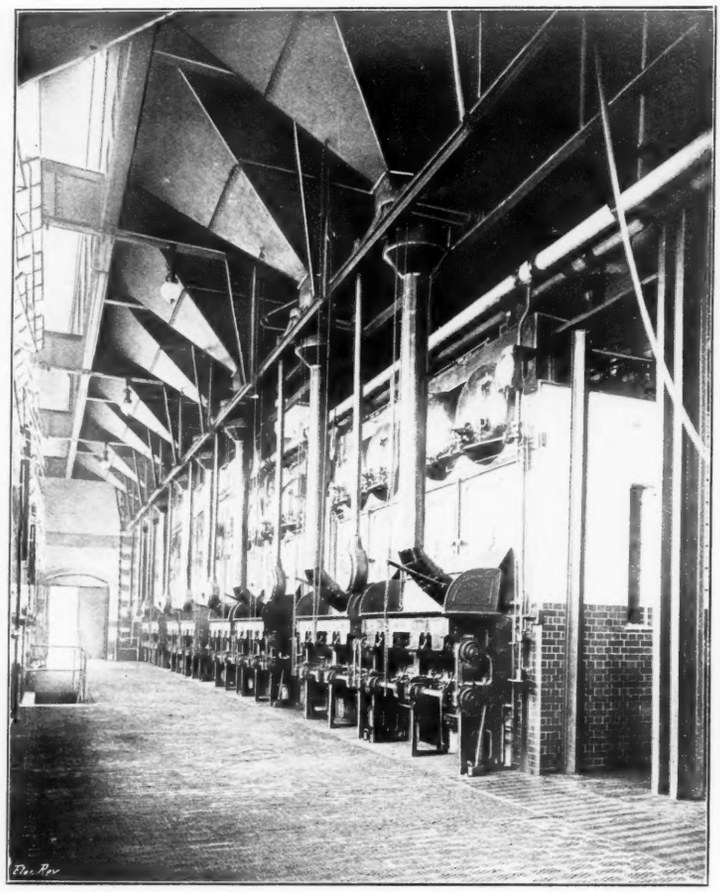


Coal Conveyer Plant.

The fuel is mechanically delivered from the basement level to the coal bunkers above the boilers. At each end of the building the coal is shot into a receiving hopper, which automatically empties it into a series of buckets on an endless

chain, by which the coal is carried to the bunkers above, and tipped automatically into them. This apparatus, which was supplied by C. W. Hunt and Co., is capable of handling 40 tons of coal per hour, and is driven electrically by a 10-H.P. motor, the driving gear being situated on the top of the bunkers. The conveyer is also used for the removal of ashes, as it runs along the basement in front of the ash pits, from which the ashes are taken by the buckets and dumped into an ash bin, which in turn shoots the ashes into a receiver outside the building.

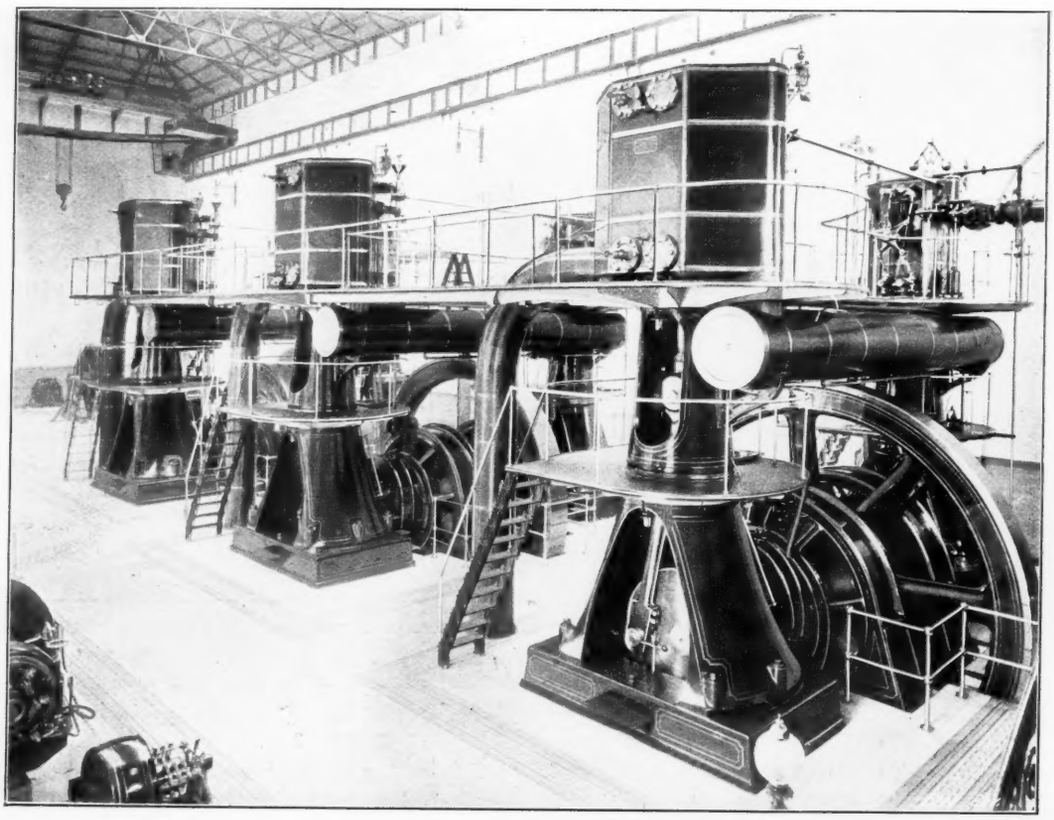
Two vertical compound Wheeler duplex pumps are located at the north end of the building, each being designed to work against a boiler pressure of 180 lbs. per square inch, with a normal piston speed of 50 ft. per minute. Each is capable of supplying 6,000 gallons of water per hour.



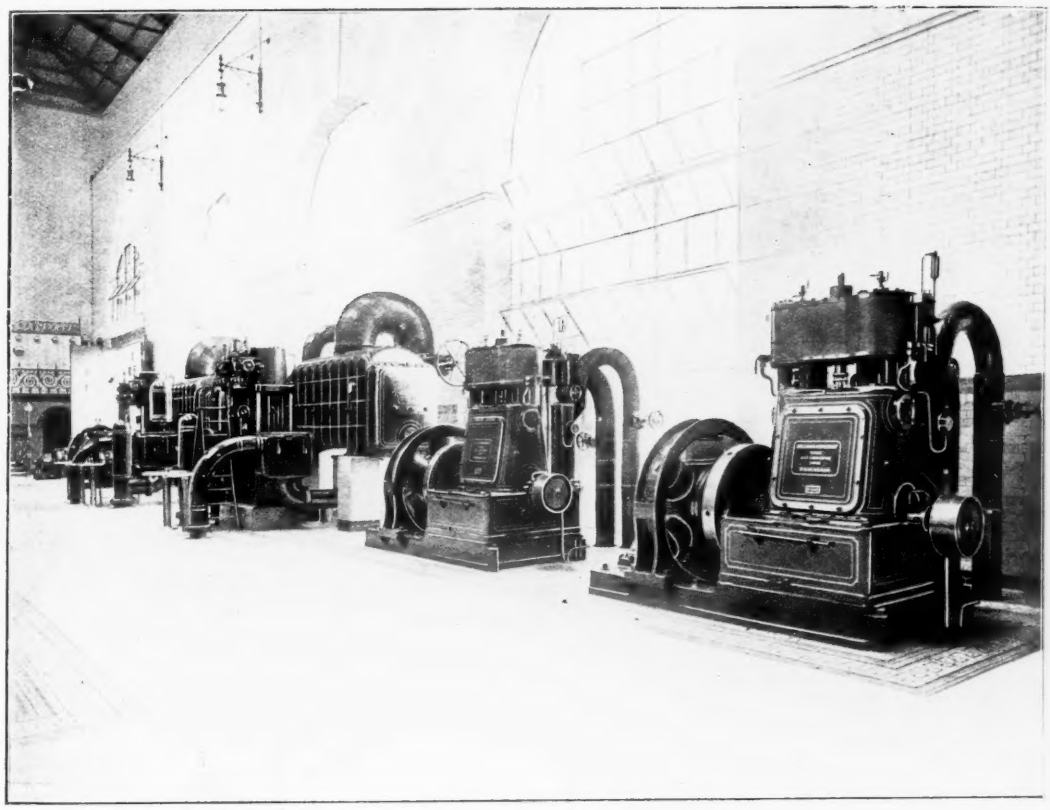
VIEW OF BOILERS.

The flue is located above the boilers, and the gases are taken up to it by breeching pieces. It is constructed of steel plates, and is 150 ft. long and 6 ft. 3 in. wide, increasing in height from 3 ft. to 13 ft. 6 in.; from this flue two branches go to the chimney. These branches are constructed of brick, and in one of them is placed the economiser, containing 360 tubes in one group of 36 sections. This economiser, which was supplied by Messrs. E. Green and Son, is provided with self-acting bevelled-edged scrapers and scraping gear driven by an electric motor.

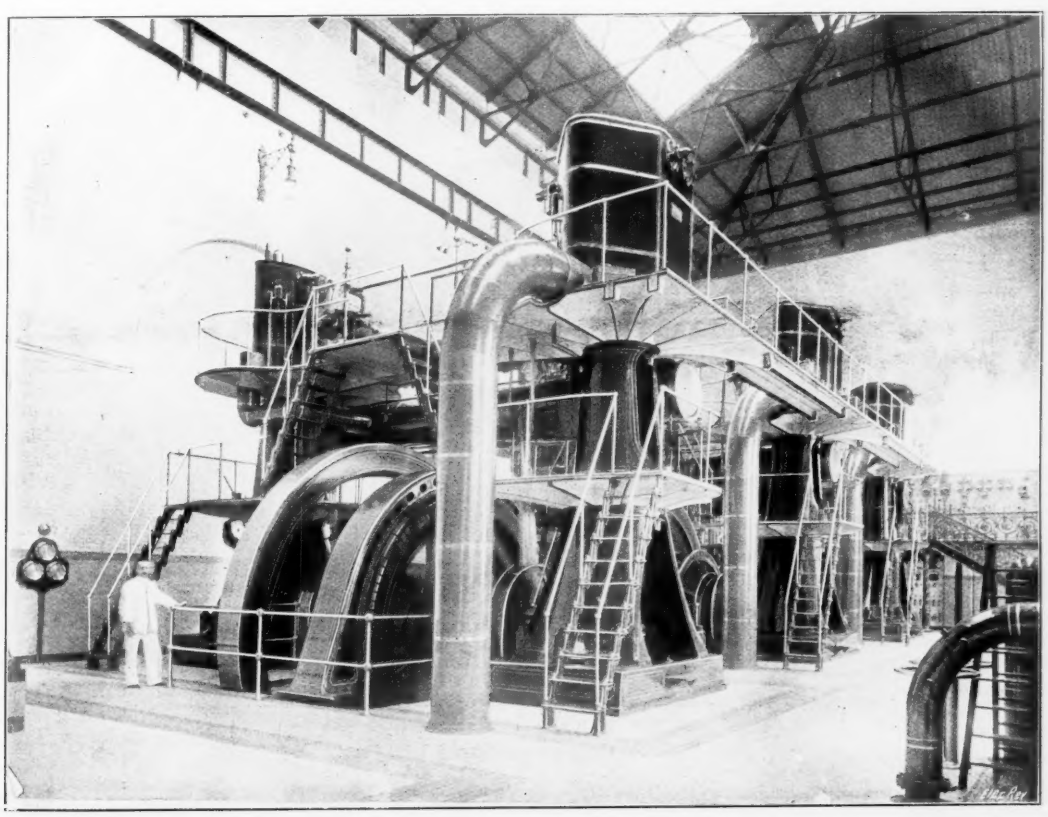
Between the flue and the coal bunkers are placed two-feed water tanks, each having a capacity of 6,000 gallons.



GENERAL VIEW OF STATION. (SEEN FROM SWITCHBOARD GALLERY.)



General View of One Side of Station.



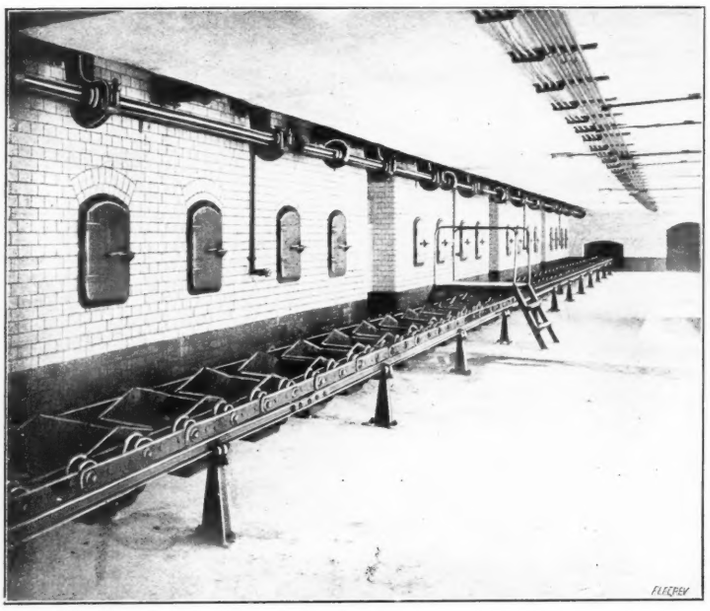
General View of Station.

The plant for softening the feed water is located outside the building, and is capable of treating 10,000 gallons of water per hour, reducing its water hardness to 5 per cent. on Clarke's scale. It consists of a cast-iron tank divided into equal compartments, 19 ft. 6 in. by 19 ft. 6 in. by 10 ft. with a re-agent tank, and a carbonating apparatus.

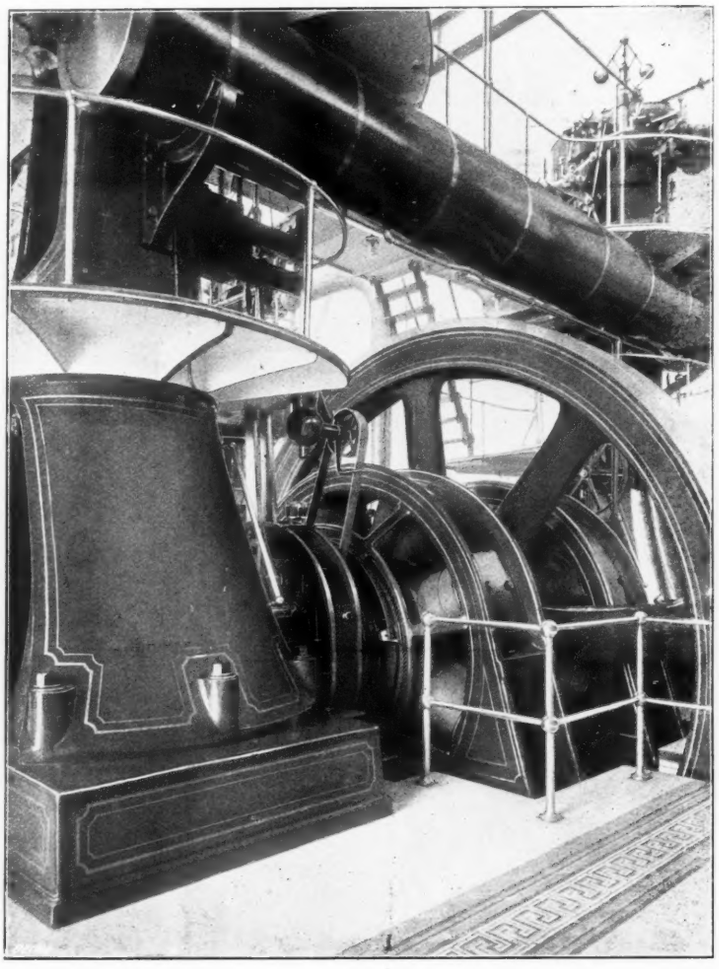
Water is obtained from three wells, consisting of 6-in. tubes driven down 30-ft., and provided with strainers at the bottom. These tubes are 20 ft. apart, and are connected with an internal pipe 4 in. in diameter, this being connected to a 6-in. main. The wells are capable of yielding 3,600 gallons per hour each with a water level not more than 16 ft. below the surface; thus 10,000 gallons per hour may be obtained continuously from the three wells.

An electrically-driven three-throw pump, capable of raising 50,000 gallons per hour, pumps the water into the water-softening tank, whence, after being softened, it is discharged into the reservoir under the cooling towers.

The engine room is 60 ft. wide, and a 25-ton electric overhead travelling crane traverses its length of 154 ft. This crane, which was supplied by Messrs. Vaughan and Son, is operated by three electric motors, one for hoisting and one each for the longitudinal and transverse motions, the motors being governed by controllers from the platform of a suspended operating cage. There are in the first place two vertical cross-compound condensing engines, supplied by Messrs. R. W. Blackwell and Co., and made by the E. P. Allis Company, with cylinders 22 in. and 44 in. by 42 in. stroke, running at 90 revolutions per minute, with a steam pressure of 150 lbs. at the throttle. Each of these engines is directly connected to two 250-KW. compound-wound direct current generators, one placed on each side of the fly-wheel. The diameter of the shafts of these engines is 22 in., and the fly-wheels, which are built up in segments, weigh 36 tons each. The variation in speed does not exceed 2½ per cent. from no load to full load. These engine sets are used for supplying power to the lines in the vicinity of the power station, and in addition there is one 500-KW. three-phase set, to which will afterwards be added two 1,000-KW. sets of the same type as the other for the transmission of power to the sub-stations. The engine runs at 94 revolutions per minute, and to it is directly coupled a 5,000-volt, 32-pole, 3-phase alternator, the frequency being 25 cycles per second. The latter is of the revolving-field type, the fields consisting of a cast-steel ring of high permeability, with outwardly projecting poles of sheet iron bolted through the rings to the spider, which is keyed to the shaft. The fields are excited from the direct current bus bars at a pressure of 500 volts. Both the direct current and the three-phase generators were supplied by the British Thomson-Houston Company.



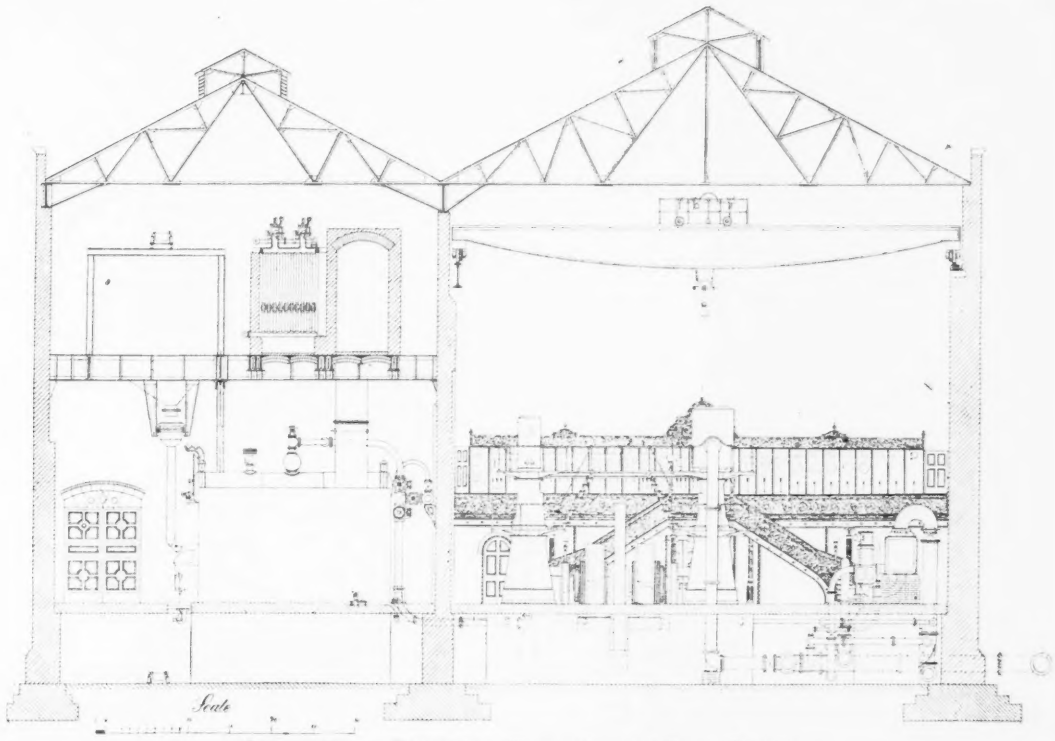
Ash Conveyer.



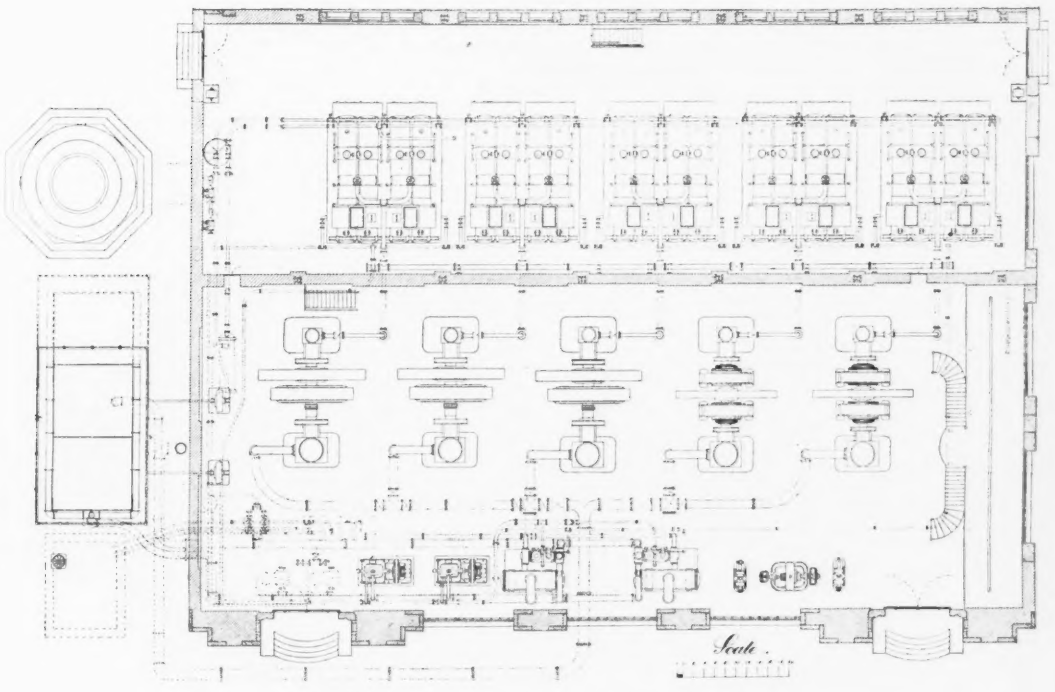
View of One of the Allis-B.T.H. Sets.

(To be continued.)

Calcium Carbide in Argentina.—About 2 miles south of the city of Cordoba, and near the Malagueno Railway, is a factory under English control for the manufacture of calcium carbide. Current is obtained from the Cordoba Light and Power Company, and plant has been laid down for the utilisation of 1,000 H.P. According to a British machinery, and tools for making the tins and drums required for packing the carbide. The lime used in the manufacture is brought 15 miles by rail from the Malagueno quarries, and the carbon is anthracite smalls from Great Britain. The present output is stated to be 25 tons of carbide per month, which will be increased to 100 tons as soon as the



London United Tramways: Cross-section of Power Station.



London United Tramways: Plan of Power Station.

Consular report, the "machinery" (perhaps this means the carbide furnaces, &c.) was received mostly from France; and the electrodes are made of "electric carbon" procured from Germany, cemented together at the works with pitch and coal tar obtained from the United Kingdom and coke from Rosario. From a more technical source we learn that the plant includes five French electric furnaces, pulverising requisite electric power is obtained. Another factory is about to be constructed with Argentine capital in the Cordoba mountains, alongside the Cordoba and North-Western Railway Company's system. The plant for this works is already lying in the custom house at Buenos Ayres. Power is to be obtained by constructing a dam across the River Primero.

ELECTRIC TRACTION NOTES.

(*Continued from page* 148.)

West Middlesex.—The Earl of Jersey opened a light railway inquiry at Hounslow on Tuesday, as to the application of the Middlesex County Council and the London United Tramways, Limited, for systems of light railways in West Middlesex. The promoters opposed each other, and the following bodies opposed either or both applications:—The Hampton, Teddington, Twickenham, Sunbury, Southall-Norwood, and Heston-Isleworth Urban District Councils; the Great Western, South-Western, and Metropolitan District Railway Companies; the water companies; the trustees of the late Sir Charles Freake, and Mr. Foster Knowles (Hampton frontager). The Teddington portion of the County Council scheme was withdrawn for non-compliance with standing orders as to deposit of plans.

Woolwich.—The M.B.C. has received notice from the London County Council of the L.C.C.'s intention to purchase the undertaking of the Woolwich and South-East London Tramways Company, and it is probable, should the purchase be completed, that the tramway lines in Powis Street will be utilised. The Auxiliary and Light Railways Company have notified the Council that they will not proceed with their scheme of a light railway to Eltham.

TELEGRAPH AND TELEPHONE NOTES.

Australian Telephone Systems.—The *Sydney Daily Telegraph* says that not a single telephone system in the Commonwealth is equipped with the most modern appliances. Of them all, perhaps, the Melbourne system, with a switchboard 30 years old in its central exchange, lags farthest behind. An inter-State conference of the electrical experts attached to the several Postal Departments—Messrs. Jenvey (Victoria), Hesketh (Queensland), Nelson (New South Wales), and Sir Charles Todd (South Australia)—has met in Melbourne to consider how the Australian telephone system can best be standardised and placed upon a uniform basis. Each of the experts can, of course, speak with authority upon the defects of the exchanges in his own State, but, in order that all of their number may be personally acquainted with the different systems, the various capitals will be visited in turn. It will cost at least £250,000 to bring the Melbourne telephone service up to date, and for the whole Commonwealth the expenditure involved in a thorough reorganisation cannot fall far short of £1,000,000, which it is presumed will be raised by loans.

It is anticipated (says the Melbourne *Argus*) that the conference will also make suggestions respecting telephone charges. Mr. R. T. Scott, the Federal Deputy Postmaster-General, favours the toll system—that is, payment calculated upon the number of times subscribers use their telephones. The recent conference of inter-State permanent heads recommended this method, and as all the electrical experts are of the same mind, their suggestion on the subject is a foregone conclusion. It will, of course, remain with the Commonwealth Cabinet to determine whether the present fixed rates are to be varied. They will seek power to do this in the Post and Telegraph Bill.

Brighton Telephones.—At the last meeting of the Brighton T.C., the Telephone Committee announced the receipt of a communication from the Postmaster-General to the effect that as the districts of Hayward Heath and Cuckfield were at present in the Horsham exchange area, he was not in a position to entertain an application for their inclusion in the Brighton area. He would, however, be willing to consider a request made by any Urban Local Authority in the area for a license to establish a telephone exchange business. The Southwick District Council would grant the Brighton Corporation permission to construct overhead telephone circuits in the district, provided all wires crossing the tramway be taken underground; that the maximum charge to a subscriber in the district did not exceed £5 10s. per annum; and also that in no case should a larger sum be charged in the district than in Brighton. The Committee decided that the Southwick D.C. and the other local authorities interested be informed that the Council had decided that for the present the charges to subscribers to the municipal telephone exchange, both within and without the County Borough of Brighton, situate within one mile from the nearest exchange, shall be as follows:—For unlimited service, £5 10s. per annum; for limited service, £3 10s. per annum, and toll 1d. per call; but that the Council reserve the right to make a further charge not exceeding a minimum of £1 5s. per annum for every additional quarter of a mile in the case of subscribers situate more than a mile from the nearest exchange. The Council are willing to agree that the charges to subscribers in the districts outside Brighton shall not at any time exceed those for the time being in force within the borough. The report was adopted, Councillor Buckwell explaining that outside districts would be charged the same as Brighton for the telephone service, namely, £5 10s.; but the Committee did not say what they would have to pay in future if the sum named did not pay.

Cape—Australia Cable.—In the House of Commons on 19th inst., Lord G. Hamilton, replying to Sir E. Sassoon, said: "An inter-Departmental Committee is now sitting to consider and report upon the question of cable communication generally. I have reason to believe that their attention has been called to the desirability in connection with the Cape—Australia cable of a spur line from Cocos to Ceylon in association with the Imperial Government as a practically all-British route from the United Kingdom to India. I await their report."

The *Sydney Daily Telegraph* for June 13th stated that "Mr. J. E. Squier, of Sydney, manager of the Eastern Extension Company, is now in Adelaide, making arrangements for landing and working the new Cape cable, which will be completed about October. The Grange will be the landing place, and a subterranean line will connect the Adelaide office. Under the agreement with the Australian Governments the company will not be able to do business direct with the public until some competing line is established at Port Adelaide. There will be a large staff to attend to the repairs of the Cape cable, and also other lines belonging to the company, so that the port will be the Australian headquarters."

Dundee Telephones.—The question of the telephone municipalisation was considered at a committee meeting of the Town Council on 19th inst. It was reported that the matter had been investigated in other centres—in Glasgow especially—and that the result of the inquiries made went to show that the Town Council should take up the question of originating a scheme of their own, or giving facilities for another company in opposition to the National Company.

Portsmouth Telephones.—Although the L.G.B. sanction has not yet been obtained, the Council is about to proceed with its municipal telephone work. The ducts are to be laid forthwith.

Telegraphic Interruptions and Repairs:—

CABLES.	INTERRUPTED.	REPAIRED.
Latakia-Cyprus	June 20, 1899	
Para-Maranham	March 1, 1900	
Basseterre-Les Saintes	June 29, 1901	
San Domingo-Curaçao	July 12, 1901	
LANDLINES:—		
Cayenne-Pinheiro	April 20, 1901	
Pekin-Kalgan	June 14, 1900	
Maimatchin-Kalgan	June 30, 1900	

Tunbridge Wells Telephones.—The municipal telephone service is to be publicly inaugurated by the Mayor and Corporation to-morrow (Saturday).

Wireless Telegraphy.—The West India Committee's circular just issued says that the Government contemplate the introduction of a system of wireless telegraphy in the West Indies. The first islands to be fitted will, it is said, be Trinidad and Tobago, while as soon as the necessary financial arrangements can be made, communication will be established between Antigua and Montserrat and between St. Kitt's and Nevis.

In the House of Commons on Monday Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, whether anything was being done to connect by telegraph the island of Sark with Guernsey; and whether he proposed to continue the policy of his predecessor in refusing an offer of Marconi's Wireless Telegraph Company to connect Sark with Guernsey by wireless telegraphy without any expense whatever to the Government. Mr. Austen Chamberlain, in reply, said the Postmaster-General has not received any fresh application for the connection by telegraph of the island of Sark with Guernsey. He was in correspondence with the Attorney-General of Guernsey, who took much trouble to obtain the necessary guarantees, but unfortunately without success. The Postmaster-General has no reason to suppose that the Marconi Wireless Telegraph Company are prepared to maintain permanent telegraphic communication between Sark and Guernsey without charge, and it is, of course, permanent communication that is required.

CONTRACTS OPEN AND CLOSED.

OPEN.

Amsterdam.—September 2nd. H.M. Consul at Amsterdam states that tenders are invited by the Municipality of Amsterdam for the supply of "electrical tram-carriages arranged for above-ground supply of electricity, and for about 5,000 tons of grooved rails for tramways, with necessary appurtenances." Particulars may be obtained from the Director of the Municipal Tramways, Nieuwe Achtergracht, No. 164, Amsterdam.

Blackburn.—July 29th. The T.C. wants tenders for three triple-expansion 775-KW. steam dynamos. See "Official Notices" July 12th.

Bradford.—July 31st. The Corporation wants tenders for 100 electric cars. See "Official Notices" July 12th.

Brecon.—August 5th. Tenders are invited for electrically lighting the Brecon and Radnor Joint Asylum now erecting at Talgarth. See "Official Notices" June 28th.

Cardiff.—August 6th. The Corporation wants tenders for double-deck bogie cars, four-wheel cars, and single-deck bogie cars; also for switchboard, with instruments. See "Official Notices" July 19th.

Dundee.—August 5th. The Gas Commissioners want tenders for condensing and cooling plant, electrically and steam driven pumps, feed heaters, &c., for the electricity works. See "Official Notices" July 12th.

East India.—The East Indian Railway Company invites tenders for the supply and delivery of steel fish plates; steel fish bolts and nuts; paints, &c.; leather belting, hides, &c.; wrought-iron material; an electric installation; girders, columns, and roof-work as per specifications to be seen at the company's offices, Nicholas Lane, E.C. Tenders are to be sent to Mr. C. W. Young, secretary, by July 31st, for the first five sections, and by August 7th for the last two.

Farnworth.—August 12th. The U.D.C. wants tenders for a car shed traverser. See "Official Notices" to-day.

France.—August 12th. Tenders are being invited until August 12th, by the French Ministry of Post and Telegraphs in Paris, for the supply of a large quantity of lead-covered telephone cable with 21 conductors. Tenders to be sent to Le Serio-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Gateshead.—July 29th. The Gateshead Co-operative Society invites tenders for an electric lighting installation (no generating plant) for their Jackson Street branch. Specifications from the electrical engineer at Jackson Street.

Glamorgan.—July 29th. The County Asylums Committee wants tenders for the electric lighting of Parc Gwyllt Asylum, near Bridgend. Tenders to Clerk of Asylums, Bridgend.

Gravesend.—July 30th. The T.C. wants tenders for water tube boilers, piping, engines, dynamos, balancer, boosters, switchboard, mains, lamp posts, battery, meters, cranes, destructor, well and water lifting apparatus. See "Official Notices" July 12th.

Hapton (Lancs.).—July 31st. The Clerk to the Parish Council is inviting tenders for the electric lighting of the township from September next to the following April.

Heckmondwike.—August 2nd. The Lighting Committee wants proposals from those willing to carry out installation work on the "free or assisted wiring system." See "Official Notices" to-day.

Holland.—September 2nd. The municipal authorities of Amsterdam are inviting tenders until September 2nd next for the supply of 5,000 tons of steel tram-rails, with accessories, required for the municipal electric tramways. Particulars may be obtained from, and tenders are to be sent to, Le Directeur des Tramways Municipaux, Nieuwe Achtergracht, 164, Amsterdam.

Kearsley.—August 1st. The U.D.C. wants tenders for tramway poles, section boxes, overhead line, &c., for 1¼ miles of tramway. See "Official Notices" July 12th.

Manchester.—August 7th. The Electricity Committee wants tenders for 70 feeder and section pillars for the tramways. See "Official Notices" July 19th.

Manchester.—August 14th. The Electricity Committee wants tenders for H.T. switchboards, exciter and auxiliary switchboards for the Stuart Street generating station, also high and low tension boards for sub-stations. See our "Official Notices" July 12th.

Newcastle-upon-Tyne.—July 29th. The Corporation wants tenders for the laying down in Gosforth of about 1,000 yards of double-line tramway, the rails and fastenings and the poles being supplied by the Corporation. On payment of £3 3s. to the City Treasurer (returnable as usual) specifications, bills of quantities, &c., may be obtained, and plans and drawings inspected, at the office of the City Engineer, Town Hall, Newcastle.

Partick.—The Council wants tenders for wiring the electricity supply station. See "Official Notices" July 19th.

Rochdale.—August 1st. The Corporation wants tenders for poles, bases, section boxes, overhead line, feeder cables, &c., for 5 miles of tramway. See "Official Notices" July 19th.

Spain.—July 30th. Tenders are being invited until the 30th inst. by the Spanish Ministry of Public Works in Madrid, for the construction and working of an electric tramway between Cadiz and San Fernando with a branch to La Carrara. Particulars may be obtained from, and tenders are to be sent to, El Ministerio de Agricultura y Obras Publicas, Madrid.

Spain.—Tenders have just been invited by the Municipal Authorities of Oliva de Jerez (province of Badajoz), for the concession for the electric lighting of the town during a period of 10 years.

Wigan.—August 10th. The Corporation wants tenders for enclosed motors and starters, 12 months' supply, 1 to 50-H.P. See "Official Notices" to-day.

Woolwich.—The M.B.C. wants tenders for the "assisted" wiring of consumers' premises. Particulars from the Town Clerk.

Worcester.—August 23rd. The Corporation wants tenders for water-tube boilers, economiser, pipes and pumps, steam dynamos, motor alternator and booster, Korting condensers, electric pumps, switchboard, crane, and battery for the new electricity works. See "Official Notices" this week.

Yarmouth.—July 27th. The Corporation wants tenders for poles, brackets, wire, insulators, overhead equipment and rail bonding; battery, switchboard and booster; also cables and joint boxes, for the electric tramways. See "Official Notices" July 12th.

CLOSED.

Austria.—Messrs. Kolben & Co., of Wysotschaun, near Prague, are reported to have secured a contract from one of the large central electric lighting stations in London for two poly-phase dynamos, each to be of no less than 5,000 H.P. capacity.

Bangor (N. Wales).—At a meeting of the District Council last week, it was reported that five tenders had been received for the supply and erection of a steam dynamo, and it was decided that the tender of Messrs. J. P. Hall & Co., for the sum of £1,633 be accepted; that being the lowest tender.

Dublin.—The Council at their meeting on Monday accepted the following tenders:—

Section	E, Condensers, Alley & Maclellan	.. ..	£3,030	0 0
,,	F, Pipework, Babcock & Wilcox	.. ..	4,805	0 0
,,	G, Feed pumps, D. Stewart & Co.	.. ..	395	0 0
,,	H, Superheaters { Part I.—John Musgrave & Sons / Part II.—Babcock & Wilcox	.. ..	832 705	0 0 0 0
,,	J, Coaling plant, Graham, Morton & Co.	.. .. ..	5,475	0 0
,,	K, Crane, Carrick & Ritchie	.. ..	670	0 0
,,	L, Workshop equipment, Easterbrook, Allcard & Co.	..	795	0 0
,,	M, Main switchboards { S. Z. de Ferranti	..	10,304	0 0
,,	N, Sub-station switch-gear			
,,	O, Transformers, British Westinghouse Electric and Manufacturing Company	.. ..	6,320	0 0
,,	P, Arc lamps, Veritys, Limited	.. ..	6,198	12 0
,,	Q, Arc lamp pillars, Veritys, Limited	.. ..	6,042	15 0
,,	R, Motors and generator, Witting Bros.	.. .. ..	3,970	0 0
,,	S, Accumulators, Electrical Power Storage Syndicate	..	751	13 6
,,	T, Meters, British Westinghouse Electrical and Manufacturing Company	.. ..	4,670	0 0
,,	U, Works wiring, W. Coates & Sons	.. ..	967	0 6

Farnworth.—The D.C. has accepted the tender of the British Insulated Wire Company, to the specification of Messrs. Lacey, Clirehugh & Sillar, for the overhead equipment of the tramway extensions.

Ipswich.—The following is a list of the tenders sent in for four boilers for the Council's new electricity works:—

*Edwin Danks & Co.	£5,020
Fraser & Fraser	5,800
John Fraser & Son	5,840
Wallsend Slipway Engineering Company	6,000
J. P. Phibbs	6,587
Robert Stephenson & Co.	6,880
Richardsons, Westgarth & Co., Limited	8,000

* Recommended for acceptance.

On the advice of Prof. Kennedy a £58,400 loan is to be applied for.

Ipswich.—The Public Health Committee recommended the acceptance of Messrs. Meldrum Brothers' tender for dust destructor plant. The cost of the scheme is £8,000. The plant will work in conjunction with the electric lighting works.

London.—The Battersea Borough Council have accepted the tender, amounting to £2,163, of Messrs. Mather & Platt for the supply of electric pumps, pipe work, &c., for condensing water, and that of Fraser & Fraser for the river work, pipes and pits for the condensing water supply for the sum of £7,000.

Tonbridge.—The Council at their meeting on Tuesday accepted the following tenders:—

Section	A, Boiler house plant, Holesworth & Sons	.. .. ..	£1,120 0
,,	B, Engine house plant (with Alley & Maclellan engines), Johnson & Phillips	.. .. ..	1,871 0 0
,,	C, Condensing apparatus and pipework, Johnson and Phillips	.. ..	1,136 0 0
,,	D, Overhead crane, Herbert Morris & Bastert	.. ..	111 11 2
,,	E, Switchboard, Veritys, Limited	.. ..	921 2 0
,,	F, Accumulators, Veritys, Limited	.. ..	1,339 16 0
,,	G, Electricity supply mains, Western Electric Company		4,002 17 0
,,	H, Public arc lighting, Improved Electric Glow Lamp Co.		444 6 0
,,	I, House meters, Chamberlain & Hookham	.. .. ..	162 0 0
,,	K, Public incandescent lighting, Improved Electric Glow Lamp Company	.. ..	331 9 6

West Ham.—The Council on Tuesday accepted the tender of Messrs. S. Z. de Ferranti in the sum of £14,240 for the supply of three 500-KW. continuous current tramway generators. The dynamos will be of Messrs. D. Bruce Peebles & Co.'s manufacture.

FORTHCOMING EVENT.

Monday, July 29th.—At 6.30 p.m. Institution of Junior Engineers. Visit to the Electric Lighting and Tramways Installation of the East Ham District Council, Nelson Street, East Ham.

NOTES.

English v. German Manufacturing.—The following comments have come to hand from a correspondent in Germany :—"Since the visit of the Institution of Electrical Engineers has drawn much attention to the manufacturing methods in Germany, a few notes on the advantages and disadvantages which that country's engineering industry possesses in comparison with the English may be of some interest. Questions of tariff, &c., it is, of course, not necessary to enter upon, but indirect, as well as direct, influences may be mentioned. Organisation is, briefly, the keynote of the German Empire, it pervades everything, and is perhaps often carried to excess ; in business it frequently tends to retard an urgent matter, but it is questionable whether this loss is not more than made up in other directions. The development of the organisation is facilitated by the military service, and the nature of the people also lends itself readily to the same end. As a consequence the management of large works is facilitated, and results in the wonderful cleanliness and order observed, which may have more than a single effect. In the first place, the order facilitates production, saves time in many trifling ways, such as finding lost articles, &c. ; and secondly, it is said to make the workman anxious to live up to it, promoting cleanly habits, regularity, &c. The German workman being slow and uninitiative, but thrifty and contented, has little inducement to strike when he is in many cases provided with a works 'restaurant,' baths, &c., and every care is taken for his health : the hours are somewhat longer, averaging about 57, and the pay, which is practically all piecework, amounts to from 30s. a week to 40s. a week in special cases. The education of the nation is hardly second to the organisation, and may be taken as a part thereof. Electricians, as turned out from the Government endowed and splendidly staffed technical schools, are easily obtainable, and the salaries could not be called excessive. Very often a complete knowledge of two or three languages is thrown in 'free of charge.' Engineers with a good laboratory training as well are also easily obtainable, but those with a practical mechanical workshop apprenticeship are not so plentiful. Everything in the large works is becoming so specialised that the all-round electrical 'engineer' is not so much in demand—at least in the works themselves. One of the greatest disadvantages the German firms labour under, is the high cost of coal. This is, however, met by using the most up-to-date plant, centralisation of power and electrical distribution. Of course the most modern labour-saving tools are universally employed : American tools seem to be especially favoured, though the German productions on similar lines are coming to the fore. The military service does not cause so much disarrangement as might be expected ; it always takes place at a young age, and hence is not very severely felt, though undoubtedly it is at times inconvenient to the management, and takes a certain period off the educational life. The latter point is certainly not very noticeable in effect, probably owing to the diligence exhibited at college, &c., while against the former point must be set the discipline obtained, which so greatly facilitates the organisation. The financial condition of the country makes money for financing purposes more difficult to obtain than with us, and there is a slump in the electrical market at present, owing to the failure of one firm. Amongst the indirect items of interest may be mentioned :—Clean, healthy cities, excellent housing for the working classes on the 'flat' principle, good and cheap tram communication, cheap living, the absence of drunkenness—especially noticeable among the working classes, cheap post and railway fares, Government examination of food, &c., to prevent adulteration. Finally, the use of a metric system throughout, reduces mental wear and tear to a minimum."

A Manchester Fatality.—The coroner's inquest on the body of George Darren, spinner, who died at the Manchester Infirmary, was held on Monday, where evidence was given as to his death, which was attributed to burns, but the medical men were unable to say whether it was caused by the fusing of the electric wire or from faulty workmanship on the part of the installing electrical engineer. It appeared from the evidence that the lamp and shade over a spinning mule fell down into the carriage. A witness said that the lamps were hung by two wires, which were separately insulated by a layer of cotton, gutta-percha, and then more cotton and "pot." There was also insulation on the main cable. Thos. Lynch, who had charge of the electric lighting machinery, said the particular lamp in use was suspended on "workshop flexible," and the only explanation of the falling of the lamp that he could give was that the wire had been cut by wearing away. In reply to questions as to the reason of the fusion, he said it might have been caused by a too high voltage, and it could also result from the creation of a "short circuit," the wires coming into contact through the insulation wearing away. After a long inquiry the jury found that the deceased had met his death accidentally in the manner indicated by the evidence, and returned a verdict to that effect.

Soldiers' Dress.—Since the article on the Electrical Engineers Volunteers, on p. 165, was set up, the writer has noticed the following confirmation of the views advanced on the advantages of red linings. In a letter to the *St. James's Gazette* of Tuesday a correspondent says :—"I tried the experiment last year and found it most successful. I think it was Colonel Maude who advocated red lining to one's hats and jackets. We live by the river, and are on it in the hottest months of the year, and used to suffer from sun headaches. Since we adopted red sunshades and the same coloured lining to hats and blouses we find no inconvenience from the chemical rays of the sun, and are able to enjoy even the heat wave without discomfort or possible chance of sunstroke."

Electrical Standardising, Testing and Training Institution.—As a result of the recent Scholarship Examination, the following awards have been made by the board of this Institution :—

To F. T. Homan, of Portsmouth Grammar School, an Exhibition value 30 guineas, tenable for two years.

To R. A. Harris, of Portsmouth Grammar School, and A. T. Morris, of Bedford Modern School, special prizes of 20 guineas each.

To S. P. Smith and H. W. Swann, special prizes of 10 guineas each.

The Quality of Continental Calcium Carbide.—An interesting report has recently been issued of the work done during 1900 by one of the chief Berlin laboratories, which make a special feature of analysing calcium carbide and the various accessories required in acetylene generation according to the specifications of the German Acetylen Verein. Of the samples of large carbide tested, 36 per cent. evolved less than 285 litres of gas per kilo. (4·53 cubic ft. per pound) ; 52 per cent. evolved between 285 and 290 litres (4·53 to 4·62 ft.) ; 8 per cent. evolved between 290 and 300 litres (4·62 to 4·76 ft.) ; and only 4 per cent. gave more than 300 litres. The samples of granulated carbide gave on an average 210 litres (3·33 ft.), the yield sometimes falling to 150 or 180 litres (2·4 to 2·9 ft.) ; and much of this stuff was "guaranteed 300 litres."

Naval Boilers.—The *St. James's Gazette* says that the second-class cruiser *Minerva* arrived at Portsmouth at half-past nine on Saturday night. Her rival in the race from Gibraltar, the second-class cruiser *Hyacinth*, reached Spithead two hours later, the ship with the cylindrical boilers thus again proving successful over the ship fitted with Belleville water-tube boilers. The *Hyacinth* reported that a stoker named Crumlish had been severely scalded through the bursting of one of her boiler tubes when the cruiser was in the Channel. The *Minerva*, the winner of the race, averaged just over 18 knots, except when going through fog. The two cruisers have gone into Portsmouth to prepare for the naval manœuvres.

Marriage.—Mr. W. E. Brandreth, resident engineer and manager of the Wycombe Electric Light Company, was married to Miss Challice, of London, at St. Martin's-in-the Fields, on the 10th inst.

Lightning Fatalities.—The storm which broke up the great heat in different parts of this country and the Continent caused an exceptionally heavy list of lightning fatalities. Six Bradford spiritualists were struck, two being killed outright, and the four so seriously injured as to be removed to hospital. A touching story comes from the French village of Palau, where four children were killed and four others and a woman were seriously injured. They believed that by ringing the church bells they would avert the lightning, but the belfry itself was struck, with the consequent death-roll mentioned. A party of five tourists and four guides climbing the Tribulaun Peak in the Tyrol were all struck. Two were killed outright, and the others "were paralysed." A military bathing establishment in Holland was struck, with the result that two men were killed, one injured, and five severely shocked. These are but a few out of the very lengthy lists of lightning accidents of the past few days.

It is interesting in view of this epidemic to refer to remarks made on the lightning question by two of our American contemporaries. The *Electrical Review* of New York, which has always preached that lightning is a negligible quantity, and the lightning conductor of little real service, says "lightning should be very little feared by anyone," and "a modern building in a city is as nearly absolutely lightning proof, and those in it are nearly absolutely protected from lightning as is possible." We turn to the columns of the *Western Electrician*, of Chicago, and find some comments on the lightning stroke which killed 11 out of 12 fisher boys, in the following vein :—

> Lightning rods probably afford some protection on isolated buildings—how much is not known, but nevertheless enough to cause the trained observers of the United States Weather Bureau to advocate their use in many cases. But how superb and yet how fearful is the complete uncertainty of the track of the atmospheric discharge! Will human knowledge ever progress to the point where electric storms may be controlled? The thought is almost a presumptuous one—but who shall say?

On another page we read that the electric lighting plant at Sulphur Springs, Texas, was struck last month, and we are led to wonder whether the building was one of modern construction, such as are "nearly absolutely lightning-proof."

"Chloride" v. "Tudor."—The cricket clubs of the Chloride Electrical Storage Syndicate, Limited, and the Tudor Accumulator Company, Limited, played a match at Dukinfield on Saturday last, resulting in a victory for the Chloride. The scores were: Chloride, 57: Tudor, 33.

Signalling.—The London and South-Western Railway Company has introduced the electro-pneumatic method of signalling between Andover and Salisbury. The Board of Trade approval is awaited.

Personal.—Mr. R. Lloyd Hughes (power station engineer, Dublin Tramway Company) was on the 13th inst. the recipient of a handsome testimonial in the form of a marble and bronze timepiece, which was presented to him as a wedding present by the engineers (past and present), running staff, and employés at the Ringsend power station.

Mr. A. S. Clift, lately of the engineering department of the Crocker-Wheeler Company, has accepted an offer from Siemens Bros. & Co., Limited, to take charge of their drafting department.

Mersey Railway.—It is officially announced, says the *Times*, that a contract has been concluded between the Mersey Railway Company, which owns the tunnel railway between Liverpool and Birkenhead, and the British Westinghouse Electrical and Manufacturing Company, for the construction of the works necessary to enable the Mersey Railway to be worked by electricity.

Appointments Vacant.—There is a vacant electrical engineering lectureship and several assistantships in the James Watt Engineering Laboratories at Glasgow University.

NEW COMPANIES REGISTERED.

Metropolitan District Electric Traction Company, Limited (70,843).—This company was registered on July 15th, with a capital of £1,000,000 in £20 shares, to adopt and carry into effect certain agreements made or intended to be made between the Metropolitan District Railway Company, of the one part, and this company or persons acting on its behalf of the other part, providing (*inter alia*) for the electrical equipment and traction of the railways of the Metropolitan District Railway Company, or any railways of which the said railway company is part or joint owner, or over which it has running powers or in which it is interested, to enter into agreements with the Metropolitan District Railway Company, and the Brompton and Piccadilly Circus Railway Company, or either of them, for the erection of a generating station or power house upon lands belonging to them or either of them, and for the working and use thereof, to construct subways and ducts, to lay down cables and rails, to build sub-stations, to alter existing stations, to execute all necessary works for the conversion of railways or tramways using steam or other form of tractive power into railways or tramways worked by electric power, to acquire from the Metropolitan District Railway Company, or any other corporation or persons, land and premises at Chelsea or elsewhere in the United Kingdom for the erection of generating stations or power houses, to equip and maintain such generating stations or power houses, to manufacture rolling stock, engines, trolleys, trucks, electric motors and machinery, and to carry on the business of electricians, engineers, producers and suppliers of electricity, contractors, financiers, &c. The subscribers are :—

	Shares.
Charles T. Yerkes, 54, Wall Street, New York City, financier	10,000
John J. Mitchell, Chicago, gentleman	1,000
Maryland Trust Company (by J. W. Brown, president), Baltimore, Maryland	4,000
George R. Webb and H. A. Parr (by J. W. Brown), Baltimore, Maryland	500
P. Calbena, 30, Broad Street, New York, lawyer	2,500
Brown Bros. & Co., 59, Wall Street, New York, bankers	2,500
Simon Borg & Co., Nassau Street, New York, bankers	1,000
Pemberton & McCados, 15, Wall Street, New York, bankers	1,000
J. G. White & Co. (by G. H. Walbridge, V.P.), 29, Broadway, New York, contractors	1,000
S. W. Marckinald, 27, William Street, New York, banker	500
Alex. Brown and Sons, Baltimore, Maryland, bankers	1,000
Henry H. Roque, 26, Broadway, New York, gentleman	2,500
H. I. Harrison, 26, Broadway, New York, secretary	100
J. G. White & Co. (by G. H. Walbridge, V.P.), 29, Broadway, New York, contractors	1,000
John H. Parsons, Union Traction Company, Philadelphia, president	250
J. W. Brown, agent, Baltimore, Maryland, president Maryland Trust Company	2,500
Gorett, Sons & Co., 4, Throgmorton Avenue, London, stockbrokers	3,150
James Phillips, jun., Hotel Lorraine, Boston, Mass., gentleman	500
T. Jefferson, Cooledge, Boston, ex-Minister to France	2,250
Frederick Ayer (by Charles F. Ayer, his attorney in fact), Boston, Mass., director of Corporations	2,500
Charles F. Ayer, Ames Building, Boston, Mass., lawyer	400
Lee, Higginson & Co., 44, State Street, Boston brokers	1,000
F. H. Prince, 14, State Street, Boston, banker	500
Charles G. Weld (by J. E. Harlow, attorney), 81, Mason Building, Boston, Mass., M.D.	1,000
Charles F. Adams (second), 23, Court Street, Boston, lawyer	100
Charles T. Yerkes, 54, Wall Street, New York City, financier	3,300
Charles T. Yerkes, 54, Wall Street, New York City, financier	3,500
Alexander Cochrane, 55, Killey Street, Boston, Mass., merchant	250
Arthur T. Lyman, P.O. Box 1,717, Boston, Mass., manufacturer	100
George P. Gardner, 22, Congress Street, Boston, Mass., trustee	100

No initial public issue. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, 50 shares; remuneration as fixed by the company.

Arc Lamps, Limited (70,795).—This company was registered on July 11th, with a capital of £60,000 in £1 shares, to adopt an agreement for the acquisition from W. J. Davy and C. W. Milne, of certain inventions for improvements in electric arc lamps, and to carry on the business of arc lamp manufacturers, electrical and mechanical engineers, machinists, fitters, millwrights, iron, brass and other metal founders, boiler makers, glass blowers and manufacturers, makers of cables and conductors, wire drawers, carbon manufacturers, spinners, electro-platers, metallurgist stampers, porcelain and stoneware manufacturers, &c. The first subscribers (each with 250 shares) are:—C. W. Milne, 51, Linden Gardens, W., accountant; E. I. Bax, Eldon, Weybridge, manager; G. McFarlane, 34, West George Street, Glasgow, consulting engineer; A. E. Bennett, Leigham Court Road, Streatham, electrical engineer; W. J. Davy, Durham Lodge, East Finchley, N., consulting engineer; J. R. Whamond, 3, Crown Court, Old Broad Street, E.C., chartered accountant; and W. R. Gaff, 3, Crown Court, Old Broad Street, E.C., chartered accountant and actuary. Minimum cash subscription 25 per cent. of any shares first offered to public. The number of directors is not to be less than two nor more than five; the first are C. W. Milne, Captain E. I. Bax, G. McFarlane, A. E. Bennett and W. J. Davy; qualification, £250; remuneration, £50 each per annum and a share in the profits.

CITY NOTES.

Great Northern and City Railway Company.

The report for the half-year ended June 30th last, to be submitted to the meeting on the 1st prox., states that at Drayton Park 1,200 lineal yards of tunnel have been driven, and only 536 yards remain to connect with Essex Road. At Essex Road the station tunnels

and connecting passages for the shafts are completed, and the cross passages between the platforms are in hand. At the Regent's Canal the up and down line tunnels have been driven southwards to a point within 69 yards of the north end of Old Street station, where the station tunnels are in course of construction. At the Finsbury Pavement terminus the connecting passages are approaching completion, and the driving of the station tunnel is being rapidly proceeded with; 400 lineal yards of double tunnel remain to be driven between the terminus and Old Street. Generally the progress made is satisfactory, and it is anticipated that the whole of the tunnelling will be completed by the end of the current year. A contract for the electrical plant and equipment will shortly be placed.

Direct United States Cable Company.

The report of the directors for the six months ended June 30th, 1901, to be presented at the meeting to be held at Winchester House on Tuesday, July 30th, at 2 p.m., reads as follows:—

Herewith the directors submit the usual statements of account for the half-year ended June 30th, 1901, which with the half-year's accounts to December 31st, 1900, presented at the ordinary general meeting on January 29th last, show the financial result on the twenty-fourth year's working of the company. The half-year's revenue, after deducting out-payments amounted to £50,649 19s. 10d., as compared with £52,204 8s. 7d. for the corresponding period of 1900, showing a difference of £1,554 8s. 9d. against the half-year under review. The working and other expenses for the same period, including income-tax, but exclusive of cost of cable repairs, amounted to £21,124 17s. 4d., leaving a balance of £29,525 2s. 6d. as the net profit, making with £5,255 13s. 2d. brought forward from the previous half-year a total of £34,780 15s. 8d. For the corresponding period of 1900, the working expenses and other payments amounted to £20,506 8s. 10d. Three quarterly interim dividends of 3s. each per share, amounting to £27,219 10s. have been declared, and paid during the financial year, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, making with the three interim dividends, 8½ per cent. for the year, being a total distribution of £39,461 10s. After transferring £10,000 to the reserve fund account, the balance of £3,532 5s. 8d. on the reserve account is proposed to be carried forward. The reserve fund account has been debited with £19,414 13s. 5d. for cost of cable repairs, and after being credited with interest on the investments and amount transferred from revenue account, now amounts to £430,996 18s. 7d., taking the investments at cost price. To the regret of his co-directors, Sir Spencer Walpole, K.C.B., has found it necessary to resign his seat on the board of the company. The vacancy thus created has been filled by the appointment of the Hon. Thos. H. A. E. Cochrane, M.P. The International Telegraph Conference, which had been appointed to meet in London in May last, has been postponed until 1902, in consequence of the death of her late Majesty Queen Victoria. Pursuant to the provisions of the articles of association, two of the directors, viz., the Hon. Thomas H. A. E. Cochrane, M.P., and John Varley, Esq., retire by rotation, and, being eligible, offer themselves for re-election. Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. J. & J. Sawyer & Co., the auditors, retire pursuant to the articles of association, and offer themselves for re-election.

Electric and General Investment Company.

The twelfth ordinary general meeting of the shareholders of this company was held on Thursday last week, at Winchester House, Old Broad Street, Mr. George Herring, the chairman, presiding.

The Chairman, in proposing the adoption of the report, said that the shareholders would see that the business had not been so good as in the previous year. As they knew, their profits were derived from making issues principally of electrical industries. He was happy to say that those issues had always been made upon a sound basis, and he thought that one of the principal causes why the public had not been investing in those good securities was that they preferred instead to gamble in other shares such as American, where the prospects of dividends ran very high. They seemed to entirely lose sight of the fact that a good safe investment was after all the most profitable in the long run. He hoped that when the present boom was over that they would be able to make issues of electrical industries in a better manner than they had been able to do lately. The trustees of the founders' shares reserve fund and the ordinary reserve fund did not propose to make any distribution for the past year in respect of those funds. As trustees they considered that the securities they held were certainly worth a great deal more than they were quoted in the market. They had not sold, in fact, they had rather increased their holdings, and they had no intention of selling, believing that in so doing they would be best promoting the interests of the company. The investments at cost, which stood in their balance-sheet at £162,413, would realise that figure; although some of them had decreased in value, others had increased. A new item in the balance-sheet this year was the £6,000 dividend on the preference shares, and that amount would have to be paid each year. For it, however, they had £100,000 to make use of, instead of having to borrow from their bankers, as in the past. The directors recommended that a final dividend of 3s. a share on the ordinary shares should be paid, making 5s. per share for the year, and a bonus of 2s. a share, and a dividend £50 per share on the founders' shares, leaving £409 to be carried to the contingency fund.

Mr. J. B. Braithwaite, jun., in seconding the resolution, said it was not to be expected that a financial company like theirs should always pay the same dividend, but he thought, looking at all which had occurred during the past year, the dividend they were proposing could not be considered unsatisfactory.

The report was then adopted.

Prospectus.

The Power-Gas Corporation, Limited, has this week been before the investing public inviting subscriptions for an issue of 183,538 ordinary £1 shares. The list closed yesterday (Thursday). The nominal capital is £350,000 in 250,000 ordinary and 100,000 deferred shares of £1 each.

The company has been formed for the purpose of developing in the United Kingdom the patented processes and inventions for the production of cheap power and heating gas (commonly known as "Mond gas") with the simultaneous recovery of sulphate of ammonia, and to carry on the manufacture and sale of the plant and apparatus and all accessories necessary to the working of these processes. For this purpose the company will acquire patents from Dr. Ludwig Mond, F.R.S., the United Alkali Company, Limited, and Mr. E. J. Duff respectively, and the entire issued share capital of Messrs. Ashmore, Benson, Pease & Co., Limited, constructional engineers, of Stockton-on-Tees.

The processes for which the company acquires the patent rights completely convert cheap qualities of coal, commonly known as slack or dross, into combustible gas, sulphate of ammonia, and ashes at one operation by means of special gas generators and ammonia recovery plant, and produce from each ton of slack about 15 times the volume of gas, and from three to four times the weight of sulphate of ammonia obtainable in the manufacture of illuminating gas. The processes have been worked out after extensive and costly experiments at the Winnington works of Messrs. Brunner, Mond & Co., Limited, and at the Fleetwood works of the United Alkali Company, Limited, where large installations have been successfully at work for some time, which have already gasified and recovered the ammonia from over 800,000 tons of slack, the gas being used for various kinds of heating operations, and also for the production of power in gas engines. Similar large installations, with ammonia recovery plant, to produce gas for power and heating purposes, are at present being erected, and near completion.

Among other statements the prospectus said:—"The economy of the processes is enhanced by the large quantities of sulphate of ammonia (one of the most potent fertilisers known), obtained, in addition to the gas, representing for every ton of fuel used a value of not less than 8s. at present prices. The cost of the gas in the vicinity of our coalfields is thus reduced to a point which makes it possible for this country to produce electricity on a large scale at a price comparing favourably with that charged to-day by the Niagara Falls Power Company. This has been proved at the works of Messrs. Brunner, Mond & Co., Limited, of Northwich, where an electrical installation of about 1,000 H.P. is and has been running almost continuously day and night for several months, the electricity being generated by means of large gas engines, working with this gas, whilst a smaller installation has been working for several years. A similar application of the gas for driving gas engines and generating electricity has for some time been in successful operation at the works of the United Alkali Company, Limited, and at the Northwich electric supply station. The application of the inventions acquired by the company will enable this country to maintain its position in a number of industries which have been most seriously threatened by the cheap water-power abroad. An important feature of these inventions is that heat and power are produced from ordinary fuel without smoke. It is anticipated that these advantages will lead to the adoption of the inventions by a large number of manufacturers and other producers of power, such as electric installations, and also to the establishment of central stations throughout the United Kingdom for the supply and distribution of the gas. It will be one of the objects of the company to organise such undertakings, and this will be facilitated by the passing of the Mond Gas Act above referred to."

New Issues.

Subscriptions have been this week invited for 17,926 ordinary £10 shares in the British Electric Traction Company, Limited. Messrs. J. S. Morgan & Co. and the Electric and General Investment Company, Limited, having exercised the option granted to them by the above company to call for allotment of the whole of the unissued share capital of the company—namely, 37,926 ordinary shares of £10 each and 10,000 preference shares of £10 each—offered for sale the above 17,926 ordinary shares, being the balance remaining unsold. The list of applications closed on Wednesday.

The Aron Electricity Meter, Limited, is now offering for subscription, at £95 per cent., 600 5 per cent. debentures of £100 each, part of a total authorised issue of £75,000. The issue is made to complete new works, to provide additional working capital, and to repay a temporary loan.

The West African Telegraph Company.

The 16th ordinary general meeting of the shareholders of this company was held on Thursday last week at Winchester House, Old Broad Street, the Marquis of Tweeddale presiding.

The Chairman, in proposing the adoption of the report, said that the gross revenue for the year ended December 31st last was £81,568, showing an increase of £4,500, which was partly due to the operation of the joint purse of the Eastern and South African Company, and also to a reduction in the amount paid for the hire of cables belonging to other companies owing to the interruption of the Dakar cable. The total working expenses had amounted to £20,388, being an increase of £90. Repairs and renewals of cables had only cost £9,035 as against £11,482. After providing for the debenture interest and sinking fund, the net results of the year's working showed a profit of £28,322. The directors proposed to place £28,000 to the reserve fund, and carry forward £322 to the next account. The revenue included £12,000 in respect of the subsidy from the French Government for 1900, and the non-payment of that amount had been provided for by transferring £12,000 from the general reserve fund to a special fund. The general reserve fund now stood at £45,331.

Sir HENRY C. MANCE seconded the motion, and the report was adopted.

The CHAIRMAN next moved "That the directors are hereby authorised to negotiate and carry out the sale or disposition of the concession now held by the company from the French Government, and of all or any of the cables or other property now belonging to the company in connection therewith, upon such terms and conditions and in such manner as the directors may think fit."

He said they would notice from the report that the French Government had still withheld the subsidies, and the amount now due from them under that head was £68,415. They would recollect that the original French concession provided for the cable being laid between Conakry and Grand Bassain, but at the date the cable was laid by their predecessors, they made an arrangement with the French Administration by which the company were permitted to make use of the African Direct Company's cable between Sierra Leone and Accra in lieu of laying a cable between Sierra Leone and Grand Bassain. They were no doubt aware that the African Direct Company was closely associated with their company, as they were co-partners in the South African joint purse. It was only about six years ago that a question arose with the French Government on this point. To lay the cable only meant throwing money away, as the communication with the French Colonies was amply sufficient, and the directors did not consider that they were justified in laying a cable which would not even earn interest on the outlay. They therefore entered into negotiations with the French Government which had continued ever since, but which had lately taken a more definite form. It was now proposed that they should surrender the concession and hand over the following cables which connected the French Colonies—the Dakar-Conakry cable, the Grand Bassain-Kotonou cable, the Kotonou-Gaboon cable, touching *en route* at San Thome. The Portuguese station at Bassain, which was at present connected with the Dakar-Conakry cable, would be disconnected, and would be connected with Bathurst direct by a new cable, the latter station being cut out of the Dakar-Conakry section. The French Government would have connection with the existing cables at Conakry, the Sierra Leone-Conakry cables remaining in the possession of the West African Telegraph Company. The Grand Bassain-Cotonou cable which touched *en route* at Accra was to be disconnected at the latter place, and the cable joined through; the French Government to have the option of continuing the connection to San Thome. Under the arrangement the French Government were to pay £112,000 on the cancellation of the concession, and a further £32,000 as and when the cables were handed over. Those sums together with the amounts in the reserve would be sufficient to pay off all the outstanding debentures, which the directors intended to at once proceed to do. He need hardly say that the arrangement had not been arrived at without a considerable amount of negotiation and anxiety. He was glad to say that it was not completed, and looked at from all points of view it was entirely in the interests of that company.

Mr. J. DENISON PENDER in seconding the resolution said that in selling these cables to the French Government, the West African through route to the Cape would not be interrupted. It was simply handing over to the French the cables which went into their own settlements in that part of the world.

The resolution was carried unanimously.

General Electric Company (1900), Limited.

THE directors' report, to be submitted at the first ordinary general meeting to be held at Cannon Street Hotel on Tuesday, July 30th, 1901, at 12 o'clock noon, reads as follows:—

The directors beg to submit to the shareholders their first annual report, together with the audited accounts to March 31st, 1901.

The net trading profits and income from investments, &c., amount to	£75,766	8	6
After deducting interest on balance of purchase money up to date of payment thereof, and on payments in advance of calls on preference shares, income-tax, depreciation and debenture interest amounting to ..	21,347	13	10
There remains an available balance of ..	£54,418	14	8

Which the directors recommend should be appropriated as follows:—

To payment of dividend on preference shares at 5 per cent. to March 31st, 1901, paid June 30th, 1901 ..	£5,778	3	5
,, payment of managing directors' and employés' bonus	4,864	1	1
,, payment of dividend on ordinary shares at 10 per cent. to March 31st, 1901	25,692	0	0
,, reserve account	18,084	10	2
	£54,418	14	8

Since the formation of the company the directors have acquired an additional 63 acres of land at Witton and Erdington, adjoining the property previously bought for the purpose of erecting modern engineering, electro-chemical and other works. The directors are hurrying on as much as possible the completion of the new works at Witton, so as to be able to start manufacturing there before the end of the present year, a matter of great importance considering the overcrowded state of their present works at Manchester and Birmingham. The board have during the past year appointed Mr. Max Railing, manager of an important department, as an additional director. Mr. Railing offers himself for re-election. The board recommend for election two additional directors, namely, Mr. Henry Bevis, manager in the firm since 1889, and Mr. Tom Hawkins, the present chief engineer at Manchester. The 692 ordinary shares issued since the formation of the company have all been allotted at par; as to seven of such shares to the subscribers of the memorandum of association, and as to the remaining 685 to members of the staff. The auditors, being eligible, offer themselves for re-election.

Globe Telegraph and Trust Company.

THE directors' report to be presented to the general meeting on July 30th reads as follows:—

The balance-sheet and accounts for the year ended July 18th, 1901, with statement of the stocks and shares held by the company at that date, are herewith submitted. The net revenue of the company for the year, after deduction of expenses, amounts to £197,136 12s. 6d., and makes, with the balance of £982 14s. 11d. brought forward, a total of £198,119 7s. 5d. From this amount there has been distributed the sum of £131,035 10s. 8d. in interim dividends, leaving an available balance of £67,083 16s. 9d. The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 4s. 6d. per share on the ordinary shares, making, with previous distributions, a total dividend for the year of 6 per cent. less income-tax, upon the preference, and 5½ per cent. net (against 5¼ per cent. for the preceding year) upon the ordinary shares, leaving a balance of £1,101 16s. 7d. to be carried forward to the next account. During the year the 6 per cent. debenture of the London-Brazilian Telegraph Company, held by this company, have been sold at a premium, to meet, in part, the cost of the new shares of the Eastern Extension, Australasia and China Telegraph Company, Limited, referred to in the last report. At a drawing of the Submarine Cable Trust certificates, which took place in April last, nine certificates in that trust, held by this company, were drawn for payment at £120, the company retaining the coupons of reversion belonging thereto. The directors much regret that, owing to his official duties, the Right Hon. St. John Broderick, M.P., resigned his position on the board. The vacancy thus occasioned has been filled up by the appointment of Sir John Wolfe Barry, K.C.B. In conformity with the articles of association, one of the directors, viz., Sir Albert J. Leppoc Cappel, K.C.I.E., retires, and, being eligible, offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., and Mr. John Newton retire, and offer themselves for re-election.

Crompton & Co., Limited.

THE thirteenth report of the directors, to be presented at the annual meeting at Winchester House, on Thursday, August 1st, at 12 o'clock noon, reads as follows:—"The directors beg to submit the annual statement of accounts and balance-sheet made up to March 31st last, from which it will be seen that the net profit for the year is £27,100 12s. 7d. After providing for debenture interest, the payment of interim dividend, and other items set out in the net revenue account, there remains, with the sum brought forward from last year, a balance of £17,926 9s. 1d. The directors propose to set aside a sum of £2,500 as a provision for doubtful debts, to place £5,000 to the reserve fund, to pay a final dividend of 9 per cent. per annum for the half-year, free of income-tax, making, with the interim dividend paid in January last, 8 per cent. for the year, and to carry forward the balance, £3,143 18s. 1d. With the above addition the reserve fund will now amount to £17,906 6s. 6d., and the directors propose to write off from this fund the sum of £5,648 6s. 10d. from patents account, which will then stand at the nominal figure of £10. The directors offered 46,000 shares for subscription in March last at the price of 5s. per share premium. 31,000 shares were applied for, when the directors closed the list and proceeded to allotment. The whole of the premiums on these shares, less the cost of issue, has been placed to reserve fund and invested outside the business. The order book continues very full, and the prospects for the future are satisfactory. In consequence of the growth of the business and the small accommodation at Mansion House Buildings, the registered offices of the company have been removed to larger premises at Salisbury House, London Wall. The building of the new arc lamp, instrument, and switchboard shops at the site of the new works is well advanced. The extensions to the works' offices is approaching completion. A new generating station and offices have been erected for the Chelmsford Electric Lighting Company, and the whole of the plant and machinery has been overhauled and, where necessary, renewed. The cost of these repairs and renewals has been charged to the lighting company's revenue, notwithstanding which fact, and the high price of coal last year, the profits of that company show a satisfactory increase. Mr. Ivor Bevan has been elected by the board a director of the company. His election requires confirmation by the shareholders. In accordance with the articles of association, Mr. Bernard Gibson retires from the board of directors by rotation, but offers himself for election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election."

Official Announcements re Companies.

THE following companies have been struck off the register and are dissolved:—

British Electro-Chemical Agency, Limited.
Economic Smoke Consumer Company, Limited.
Electric Hansom Cab and Carriage Company, Limited.
Electric Light and Power Company, Limited.
Electric, Limited.
Electric Metal Working Syndicate, Limited.
Electric Night Advertising Company, Limited.
Elieson Electrical Switch, Limited.
General Electrical Company of Roumania, Limited.
High Power Electrolyte Syndicate, Limited.
Maxim Autocar Syndicate, Limited.
Maxim Carbide Process and Acetylene Gas Syndicate, Limited.
Peterborough Electric Light and Power Company, Limited.
Pioneer Electric Carriage Company, Limited.
Pure Acetylene Gas and Carbide Company, Limited.
"Steady" Arc Lamp Company, Limited.
Telegraph Improvement Company, Limited.
Telephone Construction Company, Limited.
Towns Refuse Utilisation Syndicate (Hanson's Patents), Limited.
Treherane Electrical Engineering Company, Limited.
Universal Smokeless Furnace Company, Limited.
Wenlock Electrolytic Company, Limited.
Werner Cadmium Electric Accumulator Syndicate, Limited.
"White & Middleton" Gas Engine Company, Limited.

and connecting passages for the shafts are completed, and the cross passages between the platforms are in hand. At the Regent's Canal the up and down line tunnels have been driven southwards to a point within 69 yards of the north end of Old Street station, where the station tunnels are in course of construction. At the Finsbury Pavement terminus the connecting passages are approaching completion, and the driving of the station tunnel is being rapidly proceeded with; 400 lineal yards of double tunnel remain to be driven between the terminus and Old Street. Generally the progress made is satisfactory, and it is anticipated that the whole of the tunnelling will be completed by the end of the current year. A contract for the electrical plant and equipment will shortly be placed.

Direct United States Cable Company.

THE report of the directors for the six months ended June 30th, 1901, to be presented at the meeting to be held at Winchester House on Tuesday, July 30th, at 2 p.m., reads as follows:—

Herewith the directors submit the usual statements of account for the half-year ended June 30th, 1901, which with the half-year's accounts to December 31st, 1900, presented at the ordinary general meeting on January 29th last, show the financial result on the twenty-fourth year's working of the company. The half-year's revenue, after deducting out-payments amounted to £50,649 19s. 10d., as compared with £52,204 8s. 7d. for the corresponding period of 1900, showing a difference of £1,554 8s. 9d. against the half-year under review. The working and other expenses for the same period, including income-tax, but exclusive of cost of cable repairs, amounted to £21,124 17s. 4d., leaving a balance of £29,525 2s. 6d. as the net profit, making with £5,255 13s. 2d. brought forward from the previous half-year a total of £34,780 15s. 8d. For the corresponding period of 1900, the working expenses and other payments amounted to £20,506 8s. 10d. Three quarterly interim dividends of 3s. each per share, amounting to £27,319 10s. have been declared, and paid during the financial year, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, making with the three interim dividends, 3½ per cent. for the year, being a total distribution of £39,461 10s. After transferring £10,000 to the reserve fund account, the balance of £3,532 5s. 8d. on the reserve account is proposed to be carried forward. The reserve fund account has been debited with £19,414 13s. 5d. for cost of cable repairs, and after being credited with interest on the investments and amount transferred from revenue account, now amounts to £430,996 18s. 7d., taking the investments at cost price. To the regret of his co-directors, Sir Spencer Walpole, K.C.B., has found it necessary to resign his seat on the board of the company. The vacancy thus created has been filled by the appointment of the Hon. Thos. H. A. E. Cochrane, M.P. The International Telegraph Conference, which had been appointed to meet in London in May last, has been postponed until 1902, in consequence of the death of her late Majesty Queen Victoria. Pursuant to the provisions of the articles of association, two of the directors, viz., the Hon. Thomas H. A. E. Cochrane, M.P., and John Varley, Esq., retire by rotation, and, being eligible, offer themselves for re-election. Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. J. & J. Sawyer & Co., the auditors, retire pursuant to the articles of association, and offer themselves for re-election.

Electric and General Investment Company.

THE twelfth ordinary general meeting of the shareholders of this company was held on Thursday last week, at Winchester House, Old Broad Street, Mr. George Herring, the chairman, presiding.

The CHAIRMAN, in proposing the adoption of the report, said that the shareholders would see that the business had not been so good as in the previous year. As they knew, their profits were derived from making issues principally of electrical industries. He was happy to say that those issues had always been made upon a sound basis, and he thought that one of the principal causes why the public had not been investing in those good securities was that they preferred instead to gamble in other shares such as American, where the prospects of dividends ran very high. They seemed to entirely lose sight of the fact that a good safe investment was after all the most profitable in the long run. He hoped that when the present boom was over that they would be able to make issues of electrical industries in a better manner than they had been able to do lately. The trustees of the founders' shares reserve fund and the ordinary reserve fund did not propose to make any distribution for the past year in respect of those funds. As trustees they considered that the securities they held were certainly worth a great deal more than they were quoted in the market. They had not sold, in fact, they had rather increased their holdings, and they had no intention of selling, believing that in so doing they would be best promoting the interests of the company. The investments at cost, which stood in their balance-sheet at £162,413, would realise that figure; although some of them had decreased in value, others had increased. A new item in the balance-sheet this year was the £6,000 dividend on the preference shares, and that amount would have to be paid each year. For it, however, they had £100,000 to make use of, instead of having to borrow from their bankers, as in the past. The directors recommended that a final dividend of 3s. a share on the ordinary shares should be paid, making 5s. per share for the year, and a bonus of 2s. a share, and a dividend £50 per share on the founders' shares, leaving £409 to be carried to the contingency fund.

Mr. J. B. BRAITHWAITE, jun., in seconding the resolution, said it was not to be expected that a financial company like theirs should always pay the same dividend, but he thought, looking at all which had occurred during the past year, the dividend they were proposing could not be considered unsatisfactory.

The report was then adopted.

Prospectus.

THE Power-Gas Corporation, Limited, has this week been before the investing public inviting subscriptions for an issue of 183,538 ordinary £1 shares. The list closed yesterday (Thursday). The nominal capital is £350,000 in 250,000 ordinary and 100,000 deferred shares of £1 each.

The company has been formed for the purpose of developing in the United Kingdom the patented processes and inventions for the production of cheap power and heating gas (commonly known as "Mond gas") with the simultaneous recovery of sulphate of ammonia, and to carry on the manufacture and sale of the plant and apparatus and all accessories necessary to the working of these processes. For this purpose the company will acquire patents from Dr. Ludwig Mond, F.R.S., the United Alkali Company, Limited, and Mr. E. J. Duff respectively, and the entire issued share capital of Messrs. Ashmore, Benson, Pease & Co., Limited, constructional engineers, of Stockton-on-Tees.

The processes for which the company acquires the patent rights completely convert cheap qualities of coal, commonly known as slack or dross, into combustible gas, sulphate of ammonia, and ashes at one operation by means of special gas generators and ammonia recovery plant, and produce from each ton of slack about 15 times the volume of gas, and from three to four times the weight of sulphate of ammonia obtainable in the manufacture of illuminating gas. The processes have been worked out after extensive and costly experiments at the Winnington works of Messrs. Brunner, Mond & Co., Limited, and at the Fleetwood works of the United Alkali Company, Limited, where large installations have been successfully at work for some time, which have already gasified and recovered the ammonia from over 800,000 tons of slack, the gas being used for various kinds of heating operations, and also for the production of power in gas engines. Similar large installations, with ammonia recovery plant, to produce gas for power and heating purposes, are at present being erected, and near completion.

Among other statements the prospectus said:—"The economy of the processes is enhanced by the large quantities of sulphate of ammonia (one of the most potent fertilisers known), obtained, in addition to the gas, representing for every ton of fuel used a value of not less than 8s. at present prices. The cost of the gas in the vicinity of our coalfields is thus reduced to a point which makes it possible for this country to produce electricity on a large scale at a price comparing favourably with that charged to-day by the Niagara Falls Power Company. This has been proved at the works of Messrs. Brunner, Mond & Co., Limited, of Northwich, where an electrical installation of about 1,000 H.P. is and has been running almost continuously day and night for several months, the electricity being generated by means of large gas engines, working with this gas, whilst a smaller installation has been working for several years. A similar application of the gas for driving gas engines and generating electricity has for some time been in successful operation at the works of the United Alkali Company, Limited, and at the Northwich electric supply station. The application of the inventions acquired by the company will enable this country to maintain its position in a number of industries which have been most seriously threatened by the cheap water-power abroad. An important feature of these inventions is that heat and power are produced from ordinary fuel without smoke. It is anticipated that these advantages will lead to the adoption of the inventions by a large number of manufacturers and other producers of power, such as electric installations, and also to the establishment of central stations throughout the United Kingdom for the supply and distribution of the gas. It will be one of the objects of the company to organise such undertakings, and this will be facilitated by the passing of the Mond Gas Act above referred to."

New Issues.

SUBSCRIPTIONS have been this week invited for 17,926 ordinary £10 shares in the British Electric Traction Company, Limited. Messrs. J. S. Morgan & Co. and the Electric and General Investment Company, Limited, having exercised the option granted to them by the above company to call for allotment of the whole of the unissued share capital of the company—namely, 37,926 ordinary shares of £10 each and 10,000 preference shares of £10 each—offered for sale the above 17,926 ordinary shares, being the balance remaining unsold. The list of applications closed on Wednesday.

The Aron Electricity Meter, Limited, is now offering for subscription, at £95 per cent., 600 5 per cent. debentures of £100 each, part of a total authorised issue of £75,000. The issue is made to complete new works, to provide additional working capital, and to repay a temporary loan.

The West African Telegraph Company.

THE 16th ordinary general meeting of the shareholders of this company was held on Thursday last week at Winchester House, Old Broad Street, the Marquis of Tweeddale presiding.

The CHAIRMAN, in proposing the adoption of the report, said that the gross revenue for the year ended December 31st last was £81,568, showing an increase of £4,500, which was partly due to the operation of the joint purse of the Eastern and South African Company, and also to a reduction in the amount paid for the hire of cables belonging to other companies owing to the interruption of the Dakar cable. The total working expenses had amounted to £20,388, being an increase of £90. Repairs and renewals of cables had only cost £9,035 as against £11,482. After providing for the debenture interest and sinking fund, the net results of the year's working showed a profit of £28,322. The directors proposed to place £28,000 to the reserve fund, and carry forward £322 to the next account. The revenue included £12,000 in respect of the subsidy from the French Government for 1900, and the non-payment of that amount had been provided for by transferring £12,000 from the general reserve fund to a special fund. The general reserve fund now stood at £45,331.

Sir Henry C. Mance seconded the motion, and the report was adopted.

The Chairman next moved "That the directors are hereby authorised to negotiate and carry out the sale or disposition of the concession now held by the company from the French Government, and of all or any of the cables or other property now belonging to the company in connection therewith, upon such terms and conditions and in such manner as the directors may think fit."

He said they would notice from the report that the French Government had still withheld the subsidies, and the amount now due from them under that head was £68,415. They would recollect that the original French concession provided for the cable being laid between Conakry and Grand Bassain, but at the date the cable was laid by their predecessors, they made an arrangement with the French Administration by which the company were permitted to make use of the African Direct Company's cable between Sierra Leone and Accra in lieu of laying a cable between Sierra Leone and Grand Bassain. They were no doubt aware that the African Direct Company was closely associated with their company, as they were co-partners in the South African joint purse. It was only about six years ago that a question arose with the French Government on this point. To lay the cable only meant throwing money away, as the communication with the French Colonies was amply sufficient, and the directors did not consider that they were justified in laying a cable which would not even earn interest on the outlay. They therefore entered into negotiations with the French Government which had continued ever since, but which had lately taken a more definite form. It was now proposed that they should surrender the concession and hand over the following cables which connected the French Colonies—the Dakar-Conakry cable, the Grand Bassain-Kotonou cable, the Kotonou-Gaboon cable, touching *en route* at San Thome. The Portuguese station at Bassain, which was at present connected with the Dakar-Conakry cable, would be disconnected, and would be connected with Bathurst direct by a new cable, the latter station being cut out of the Dakar-Conakry section. The French Government would have connection with the existing cables at Conakry, the Sierra Leone-Conakry cables remaining in the possession of the West African Telegraph Company. The Grand Bassain-Cotonou cable which touched *en route* at Accra was to be disconnected at the latter place, and the cable joined through; the French Government to have the option of continuing the connection to San Thome. Under the arrangement the French Government were to pay £112,000 on the cancellation of the concession, and a further £32,000 as and when the cables were handed over. Those sums together with the amounts in the reserve would be sufficient to pay off all the outstanding debentures, which the directors intended to at once proceed to do. He need hardly say that the arrangement had not been arrived at without a considerable amount of negotiation and anxiety. He was glad to say that it was not completed, and looked at from all points of view it was entirely in the interests of that company.

Mr. J. Denison Pender in seconding the resolution said that in selling these cables to the French Government, the West African through route to the Cape would not be interrupted. It was simply handing over to the French the cables which went into their own settlements in that part of the world.

The resolution was carried unanimously.

General Electric Company (1900), Limited.

The directors' report, to be submitted at the first ordinary general meeting to be held at Cannon Street Hotel on Tuesday, July 30th, 1901, at 12 o'clock noon, reads as follows:—

The directors beg to submit to the shareholders their first annual report, together with the audited accounts to March 31st, 1901.

The net trading profits and income from investments, &c., amount to	£75,766	8 6
After deducting interest on balance of purchase money up to date of payment thereof, and on payments in advance of calls on preference shares, income-tax, depreciation and debenture interest amounting to ..	21,347	13 10
There remains an available balance of ..	£54,418	14 8

Which the directors recommend should be appropriated as follows:—

To payment of dividend on preference shares at 5 per cent. to March 31st, 1901, paid June 30th, 1901 ..	£5,778	3 5
,, payment of managing directors' and employés' bonus	4,864	1 1
,, payment of dividend on ordinary shares at 10 per cent. to March 31st, 1901	25,692	0 0
,, reserve account	18,084	10 2
	£54,418	14 8

Since the formation of the company the directors have acquired an additional 63 acres of land at Witton and Erdington, adjoining the property previously bought for the purpose of erecting modern engineering, electro-chemical and other works. The directors are hurrying on as much as possible the completion of the new works at Witton, so as to be able to start manufacturing there before the end of the present year, a matter of great importance considering the overcrowded state of their present works at Manchester and Birmingham. The board have during the past year appointed Mr. Max Railing, manager of an important department, as an additional director. Mr. Railing offers himself for re-election. The board recommend for election two additional directors, namely, Mr. Henry Bevis, manager in the firm since 1889, and Mr. Tom Hawkins, the present chief engineer at Manchester. The 692 ordinary shares issued since the formation of the company have all been allotted at par; as to seven of such shares to the subscribers of the memorandum of association, and as to the remaining 685 to members of the staff. The auditors, being eligible, offer themselves for re-election.

Globe Telegraph and Trust Company.

The directors' report to be presented to the general meeting on July 30th reads as follows:—

The balance-sheet and accounts for the year ended July 18th, 1901, with statement of the stocks and shares held by the company at that date, are herewith submitted. The net revenue of the company for the year, after deduction of expenses, amounts to £197,135 12s. 6d., and makes, with the balance of £982 14s. 11d. brought forward, a total of £198,119 7s. 5d. From this amount there has been distributed the sum of £131,035 10s. 8d. in interim dividends, leaving an available balance of £67,083 16s. 9d. The directors recommend the payment of a final dividend for the year of 8s. per share on the preference shares, and of 4s. 6d. per share on the ordinary shares, making, with previous distributions, a total dividend for the year of 6 per cent. less income-tax, upon the preference, and 5¼ per cent. net (against 5¼ per cent. for the preceding year) upon the ordinary shares, leaving a balance of £1,101 16s. 7d. to be carried forward to the next account. During the year the 6 per cent. debenture of the London-Brazilian Telegraph Company, held by this company, have been sold at a premium, to meet, in part, the cost of the new shares of the Eastern Extension, Australasia and China Telegraph Company, Limited, referred to in the last report. At a drawing of the Submarine Cable Trust certificates, which took place in April last, nine certificates in that trust, held by this company, were drawn for payment at £120, the company retaining the coupons of reversion belonging thereto. The directors much regret that, owing to his official duties, the Right Hon. St. John Broderick, M.P., resigned his position on the board. The vacancy thus occasioned has been filled up by the appointment of Sir John Wolfe Barry, K.C.B. In conformity with the articles of association, one of the directors, viz., Sir Albert J. Leppoc Cappel, K.C.I.E., retires, and, being eligible, offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., and Mr. John Newton retire, and offer themselves for re-election.

Crompton & Co., Limited.

The thirteenth report of the directors, to be presented at the annual meeting at Winchester House, on Thursday, August 1st, at 12 o'clock noon, reads as follows:—"The directors beg to submit the annual statement of accounts and balance-sheet made up to March 31st last, from which it will be seen that the net profit for the year is £27,100 12s. 7d. After providing for debenture interest, the payment of interim dividend, and other items set out in the net revenue account, there remains, with the sum brought forward from last year, a balance of £17,926 9s. 1d. The directors propose to set aside a sum of £2,500 as a provision for doubtful debts, to place £5,000 to the reserve fund, to pay a final dividend of 9 per cent. per annum for the half-year, free of income-tax, making, with the interim dividend paid in January last, 8 per cent. for the year, and to carry forward the balance, £3,143 18s. 1d. With the above addition the reserve fund will now amount to £17,906 6s. 6d., and the directors propose to write off from this fund the sum of £5,648 6s. 10d. from patents account, which will then stand at the nominal figure of £10. The directors offered 46,000 shares for subscription in March last at the price of 5s. per share premium. 31,000 shares were applied for, when the directors closed the list and proceeded to allotment. The whole of the premiums on these shares, less the cost of issue, has been placed to reserve fund and invested outside the business. The order book continues very full, and the prospects for the future are satisfactory. In consequence of the growth of the business and the small accommodation at Mansion House Buildings, the registered offices of the company have been removed to larger premises at Salisbury House, London Wall. The building of the new arc lamp, instrument, and switchboard shops at the site of the new works is well advanced. The extensions to the works' offices is approaching completion. A new generating station and offices have been erected for the Chelmsford Electric Lighting Company, and the whole of the plant and machinery has been overhauled and, where necessary, renewed. The cost of these repairs and renewals has been charged to the lighting company's revenue, notwithstanding which fact, and the high price of coal last year, the profits of that company show a satisfactory increase. Mr. Ivor Bevan has been elected by the board a director of the company. His election requires confirmation by the shareholders. In accordance with the articles of association, Mr. Bernard Gibson retires from the board of directors by rotation, but offers himself for election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election."

Official Announcements re Companies.

The following companies have been struck off the register and are dissolved:—

British Electro-Chemical Agency, Limited.
Economic Smoke Consumer Company, Limited.
Electric Hansom Cab and Carriage Company, Limited.
Electric Light and Power Company, Limited.
Electric, Limited.
Electric Metal Working Syndicate, Limited.
Electric Night Advertising Company, Limited.
Elieson Electrical Switch, Limited.
General Electrical Company of Roumania, Limited.
High Power Electrolyte Syndicate, Limited.
Maxim Autocar Syndicate, Limited.
Maxim Carbide Process and Acetylene Gas Syndicate, Limited.
Peterborough Electric Light and Power Company, Limited.
Pioneer Electric Carriage Company, Limited.
Pure Acetylence Gas and Carbide Company, Limited.
"Steady" Arc Lamp Company, Limited.
Telegraph Improvement Company, Limited.
Telephone Construction Company, Limited.
Towns Refuse Utilisation Syndicate (Hanson's Patents), Limited.
Treherane Electrical Engineering Company, Limited.
Universal Smokeless Furnace Company, Limited.
Wenlock Electrolytic Company, Limited.
Werner Cadmium Electric Accumulator Syndicate, Limited.
"White & Middleton" Gas Engine Company, Limited.

British Thomson-Houston Company.

THE sixth ordinary general meeting of this company was held at the offices, 83, Cannon Street, E.C., on Monday, Mr. E. A. Lazarus presiding.

The CHAIRMAN said that there was nothing to add to what was contained in the report (which has already appeared in the ELECTRICAL REVIEW). He formally moved its adoption, and this was seconded by Mr. A. R. MONKS, and carried. The re-election of directors was moved by General GRIFFIN, and carried. The auditors (Messrs. Price, Waterhouse & Co.) having been re-elected, the meeting closed with the usual vote of thanks to the chairman.

United River Plate Telephone Company.

AN extraordinary meeting of the shareholders of the above company was held on the 18th inst. at the offices, Dashwood House, Old Broad Street, E.C., under the chairmanship of Mr. Courtenay, when resolutions confirming the alterations agreed to at the annual meeting in the articles of association, to bring them into conformity with the new Act, were passed.

Anglo-American Telegraph Company.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending June 30th, 1901, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income-tax, payable on August 1st to the stockholders registered on the books of the company on June 30th, 1901. After paying the foregoing dividends, there will be a balance of about £6,378 to be carried forward to the next account.

City of London Electric Lighting Company.—The directors have declared a dividend on account of the distribution for the year 1901, on the company's 6 per cent. cumulative preference shares of 6s. per share, being at the rate of 6 per cent. per annum, for the half-year ended June 30th, payable on August 3rd.

Liverpool Overhead Railway Company.—The accounts for the past half-year show an available balance of £11,722, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares, and 2 per cent. per annum on the ordinary shares against 3 per cent. per annum on the ordinary shares for the corresponding period last year. Balance carried forward £3,722.

Stock Exchange Notices.—The Committee has been asked to allow the following securities to be quoted in the Official List:—Brompton and Kensington Electricity Supply Company, Limited, further issue of 8,000 7 per cent. cumulative preference shares of £5 each, fully paid, Nos. 50,001 to 58,000; County of London and Brush Provincial Electric Lighting Company, Limited, further issue of £100,000 4½ per cent. debenture stock.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending July 19th were £632; corresponding week last year, £540; increase, £92. Total to date, £13,795, corresponding period last year, £12,545; increase, £1,250. Miles of track open, 8½.

Blackpool and Fleetwood Tramways.—The receipts for six days ending July 20th were £1,367; corresponding week last year, £1,491: decrease, £124. Total to date. £3,193; corresponding period last year, £3,242; decrease, £49.

Bristol Tramways and Carriage Company.—The receipts for the week ending July 19th were £5,097; corresponding period last year, £3,605; increase, £1,492.

Central London Railway.—The receipts for the week ending July 20th were £6,218; previous week, £6,145; increase, £73. Total receipts to date (three weeks), £18,442. Miles open, 6.

City and South London Railway.—The receipts for the week ending July 21st were £1,800; corresponding week last year, £1,411; increase, £389. Total to date, £5,644; corresponding period last year, £4,294; increase, £1,350. Miles open, 4¾.

Dover Corporation Tramways.—The receipts for the week ending July 20th were £279 19s. 1½d.; corresponding week last year, £283 0s. 2½d.; decrease, £3 1s. 1d. Total to date, £5,662 16s. 2½d.; corresponding period last year, £5,292 17s. 11½d.; increase, £369 18s. 3d. Miles of track open, 3. Car miles run, 1901, 5,123; 1900, 5,036. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending July 19th were as follows:—D.U.T. Co., electric cars, £4,207 17s. 4d.; D.S.D. Co., electric cars, £1,336 9s. 2d.; total, £6,544 6s. 6d.; corresponding period last year—D.U.T. Co., electric cars, £3,937 10s. 3d.; ditto, horse cars, £33 4s. 11d.; D.S.D. Co., electric cars, £1,301 15s. 9d.; total, £5,272 10s. 11d.; increase, £271 15s. 7d.; aggregate to date, £14,415 5s. 2d.; aggregate to date last year, £13,572 9s. 6d.; increase, £842 15s. 8d. The mileage worked is 45 miles electrically, as against 42 miles electrically, and two miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending July 21st were £1,801; corresponding week last year, £1,751; increase, £50. Total from July 1st to date, £5,398; corresponding period last year, £5,193; increase, £105. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

CONFIDENCE in financial matters seems to be just as shy in returning as is business, and there is little improvement to report as regards quotations this week. From the dealers in electrical supply descriptions we hear that they are getting their full share of what small amount of general business is passing in the Stock Exchange markets. Steady investment orders keep supply shares fairly firm, but the telegraph department is very inactive. Only here and there is any trade noticeable. The electrical railway section is participating in the atmosphere of doleful excitement now apparent amongst all home rails in consequence of the wretched dividend distributions. In the miscellaneous market a small crop of new emissions is arousing interest, but no lively dealing has been started in any of the latest arrivals.

City and South London stock yielded a point upon the appearance of the company's report, which was not much liked. The declaration of a higher dividend had led to anticipations of better things than the accounts disclosed, but perhaps the market was expecting too much. "Tube" Ordinary is also rather weaker, but the Preferred continues in demand, and is 1 per cent. better. Waterloo and City stock is off to the same extent. Great Northern and City "A" shares are easier at 8.

All the interest in electrical railway matters, however, is now concentrated upon the electrification of the two Underground lines. The District, as was announced some months back, has rushed into the arms of a syndicate almost entirely American, headed by Mr. C. T. Yerkes, who takes 16,800 shares in the new Metropolitan District Electric Traction Company, Limited. The Metropolitan is still favouring the Ganz system, but in the event of a disagreement between the two companies the question of system is to be settled by a tribunal acting under the Board of Trade. Metropolitan stock has been over 81 within the week and now stands at a point below 80. The chairmanship of the company is to be taken over by Sir Christopher Furness, as level-headed and practical a man of business as could well be found for the difficult position. District stock keeps in the fractional neighbourhood of 29.

British Electric Traction Preference are ¼ down, and the Ordinary are easier as well, upon the offer of Messrs. J. S. Morgan and Co., conjointly with the Electric and General Investment Company, Limited, of 17,926 Ordinary shares at £13 per share. These are the remaining shares over which the two firms were given an option eight months ago in consideration of their guaranteeing the last new issue. Full details have been extensively published already. Shareholders are busily selling their old Ordinary in order to acquire the wherewithal necessary to pay for the new, which are in several respects cheaper than the old. But it must be remembered that the question of market ability should be considered before an exchange is made, and the old shares are much more easily negotiated than are the new, for which no present market exists. There is, of course, little doubt that the whole issue will be found easily subscribed.

Another new issue of considerable interest is that of Ferranti, Limited. The lists for the securities offered were closed to-day (Wednesday), as were those for the new British Electric Traction Ordinary. No attempt has been made so far to establish any dealings in the shares. A third electrical investment is provided by the Aron Electricity Meter, which sought £60,000 in 5 per cent. debentures at 95. The rate of interest and price of issue speak for themselves; no investor would imagine he was getting anything particularly gilt-edged on such terms. The Ordinary shares stand at 13s. 9d., and the 6 per cent. Preference are 12s. 6d., both being £1 shares, fully paid.

The supply share market is inclined to dulness, and the recordable changes are made up of five recessions against one advance. The former are amongst the higher-class descriptions, simply reflecting the flatness of consols, and investment markets as a whole. Some anxiety is expressed as to whether the companies will be able to maintain their dividends of 1900, the increased cost of coal and labour considered, but the St. James's dividend should have reassured the pessimists. Shareholders in the best electric lighting concerns will notice with amusement the dividend on Gas, Light and Coke Ordinary stock for the past half-year. It is but £4 8s. per cent., the same as was paid last February, and the company's stock is standing at 98.

In the telegraph division Anglo-American Preferred is down a little, for although the dividend of 15s. per cent. on the Ordinary is maintained, the carry forward is £2,322 lower. In the Eastern group, a demand for the pre-Ordinary is the most noticeable feature, and is responsible for the pair of rises, while West African Debentures have now gained a premium of 1½ per cent. Globe Ordinary are 5s. better upon the satisfactory report just out. But the telegraph market is very slow, and the telephone is not much gayer. National Ordinary exhibit a declining tendency, but there is a widening of the prices in the Preference issues, which makes them somewhat better.

Telegraph Constructions are £1 higher. Babcock & Wilcox shares keep quietly at 2⅞, the 6 per cent. Preference at 1⅝. Willans & Robinson Ordinary are 10½, and business has been marked in the Preference (£5 shares) at 6⅛. Callender's Debenture is lower, but there is no change in the Henley's descriptions. Crompton & Co. have issued a good report, which shows that the business is now on a sound profit-earning basis, with 8 per cent. per annum for the Ordinary. The General Electric (1900) report is good, but has failed to stimulate business in the officially-quoted Preference, which are 10, while the Debentures are exactly par.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for he last three years. 1898.	1899.	1900.	Closing Quotations July 17th.	Closing Quotation July 24th.	Business done during week ended July 24th. 1901. Highest.	Lowest
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	98 —101 xd	98 —101 xd	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,200 Red. ...	100	...	...	...	78 — 83	78 — 83	...	...
822,700£	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	53 — 56	53 — 56	...	...
3,088,540£	Do. do. 6 % Pref	Stock	6 %	6 %	6 %	98 —100	99 —101	100	99½
3,088,540£	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	9⅞— 10¼	9⅞— 10¼	10	9 13/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3⅞— 4¼	3⅞— 4¼	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	175 —185 xd	175 —185	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	100 —102 xd	101 —103	102	101½
16,000	Cuba Telegraph	10	8 %	7 %	...	7 — 8	7 — 8	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	14½ — 15½	14½ — 15½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	99 — 103 xd	99 —103⅝ xd	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½— 11½	10½— 11½	10⅞	10⅝
104,300£	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102 xd	99 —102 xd	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	143 —148	143 —148	148	145
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	80 — 92	91 — 94	93	90½
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	109 —113	110 —114	113	112⅜
300,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	13¾— 14¼	13¾— 14¼	14⅛	13⅝
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	110 —115	110 —115	111	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5¼ %	...	100 —103	100 —103	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103%	100 —103%	101	...
180,227	Globe Telegraph and Trust	10	5⅛%	5⅛%	5⅛%	9¾ — 10¼	10 — 10⅛	10¼	10
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14¾— 15½	14¾— 15½	15⅛	14⅞
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	30 — 32	30 — 32	31	...
78,000£	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102 xd	99 —102 xd	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	43 — 47	43 — 47	45	43½
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅜— 3⅝	3½— 3½	3 13/16	3⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 12	11 — 13	11½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 12	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅛— 4⅜	4⅛— 4⅜	4 3/16	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	90 — 93	90 — 93	90	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	...	4 %	95 — 98	95 — 98 xd	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	⅞— 1	⅞— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102 xd	99 —102 xd	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	7½	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	125 —130	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½	5 — 5½xd	...	...
40,006	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅜— 5¼xd	4⅜— 5¼ xd	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	101 —104	101 —104 xd	...	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	98 —101	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜— 14¼	13⅜—14¼ xd	14 3/16	13 15/16
75,000£	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104 xd	101 —104 xd	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	100 —103 xd	100 —103 xd	...	...
88,321	West India and Panama Telegraph	10	2 %	⅝%	...	⅜— ⅝	⅜— ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	5 — 6	5 — 6	5⅛	5
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	3 — 5	3 — 5	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	101 —104 xd	101 —104 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7⅜— 8¼	7⅜— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8½— 9	8½— 9	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10	9 — 10	...	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅜	5¼— 5⅜	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5½— 6	5½— 6	...	...
150,000£	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	107 —110 xd	107 —110	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	0 %	8 — 9	8 — 9	8½	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	12½— 13½	12½— 13½	...	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	120 —125 xd	120 —125 xd	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	4 %	8½— 9½	8½— 9½	9¼	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13	12 — 13	...	...
200,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	103 —106 xd	103 —106 xd	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5½— 6 xd	5½— 6	5 13/16	5 9/16
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5½— 6 xd	5½— 6	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	102 —105 xd	102 — 105xd	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11½— 12⅝	11 — 12	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	102 — 105	102 —105	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	96 —100	96 —100	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	13 — 14	13½— 14½	13⅝	13 5/16
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	108 —111 xd	108 —111 xd	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	94 — 97 xd	94 — 97 xd	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15 — 16 xd	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	15	14½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	8½— 9½	...	...
150,000£	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	97 —100 xd	97 —100 xd	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½%	11½— 12½	11½— 12	11⅞	11⅝

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
‡ Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation July 17th.	Closing Quotation July 24th.	Business done week ended July 24th, 1901. Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7 — 8	7 — 8	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	89 — 93	89 — 93	...	...
45,000	British Electric Traction	10	6 %	8 %	9 %	14 — 15	14 — 14½xd	14⅝	14
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 12½	12 7/16	12¼
350,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	122 —125	122 —125	124½	123
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	10 — 11	10 — 11	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6¼xd	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅝— 1⅞	1½— 1¾	1½	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛— 2⅜	2 — 2¼	2¼	2
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108	103 —108	...	...
108,710*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	99 —102 xd	99 —102	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	14 — 15	14 —15	14⅜	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	107 —111 xd	...	...
206,297	Central London Railway, Ord. Stock	Stock	...	...	...	90 — 93	90 — 93	93	...
78,703	Do. do. Pref. half-shares	5	...	...	...	98 — 101	99 —102	101	100½
78,703	Do. do. Def. do.	5	...	...	...	92 — 95	92 — 95	...	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1½%	54 — 56	53 — 55	53	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	5½— 5⅝	5½— 5⅝	..	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3½— 4	3½— 4	3¾	...
100,000*l*	{ Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red }	...	...	...	...	100 —105 xd	100 —105	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1 — 1½	1 — 1½	1	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	2 — 3	2 — 3	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	80 — 85 xd	80 — 85	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	92 — 96	92 — 96	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6%	1⅝— 2¼xd	1⅝— 2¼xd	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½— 3 xd	2½— 3 xd	1⅞	1 13/16
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 —102 xd	98 —102 xd	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	15½— 16½	15½— 16½	16½	...
35,000	Do. do. do. 4½ % Pref.	5	...	4½%	4½%	5½— 6	5½— 6	5⅞	5⅝
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21¾	21⅛
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3¾%	3½%	8⅛— 8½	8 — 8½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 13¼	13 — 13½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	... — ...	19/- to 20/-	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	36 — 40	37 — 41 xd	39½	38
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	... %	...	101 —104 xd	101 —104 xd	102¾	102½
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	12 %	10½— 11½	10½— 11½	10⅞	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½— 6	5½— 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	91 — 94	90 — 93	93	90

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅞—1
National Electric Free Wiring, 12/6 paid, 1/16—1/8.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16½.
Do. do. Pref. (£10 pd.), 10—11.
*T. Parker, £10 (fully paid), 16½.

* From Birmingham Share List.

Bank rate of discount 3½ per cent. (June 6th, 1901).

MARKET QUOTATIONS, Wednesday, July 24th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a „ „ ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£15	£15	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£23	£23	..
a Lead, Nitrate	per ton	£24	£24	..
a „ White Sugar	per ton	£31	£31	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8¾d.	8¾d.	..
a „ Caustic (75/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	61/-	61/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£3	£3	..
Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £140	£75 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c Tube (brazed)	per lb.	10d.	10d.	..
c „ „ (solid drawn) ..	per lb.	8½d.	8½d.	..
c „ Wire, basis	per lb.	8d.	8d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c „ „ (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£85	£85	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£85	£85	..
g „ Rod	per ton	£85	£85	..
e „ (Electrolytic) Bars ..	per ton	£82	£82	..
e „ „ Sheets	per ton	£90	£90	..
e „ „ Rod ..	per ton	£84	£84	..
e „ „ H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/6½ to 3/8	3/8 to 3/9	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants) ..	per ton	45/-	44/8	4d. inc.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i „ Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	{ £12 7 6 to £12 10	£12 7 6 to £12 10 }	..
g „ „ Sheet	per ton	£13 10	£13 10	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p „ rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ „ strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10½d. to 1/0½	10½d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i „ „ in bars		£58	£58	..
g Tin, block	per ton	{ £125 to £126	£129 to £131 }	dec.
g „ foil	per lb.	1/6	1/6	..
n „ wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals —				
"White Ant" brand	per ton	£35 to £65	£35 to £65	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	8¼d.	8¼d.	..
j „ Best Flax, 6 lea.	per lb.	6d.	6d.	..
j „ Hemp, 3 ply 10 lbs. ..	per lb.	4¾d.	4¾d.	..
j „ „ Russian, 10 lbs. ..	per lb.	5¾d.	5¾d.	..
j „ Jute, 180 lbs. rove ..	per ton	£14	£14 5	5s. dec.
k Zinc, Sh's. (Vielle Montagne bnd.)	per ton	£22 10	£22 10	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yee & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd *p* The Phosphor Bronze Company Ltd

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

THE NEW TRUNK EXCHANGE No. I. BERLIN.

THE new Berlin Trunk Exchange which has been recently installed, and at which it is intended to deal with the whole trunk wire traffic of that city, has been fully described by Herr Lindow in the *Elektrotechnische Zeitschrift*, and presents many points of novelty and interest. The office has been fitted up with the most modern apparatus at a cost of about £62,500, and has a capacity of 10,600 subscribers' lines and 1,600 outgoing local and sub-exchange junctions. The lines are brought into the exchange partly overhead and partly underground. The overhead bare wires are led down in 28-wire india-rubber lead-covered cables from the iron derrick on the roof to the fuse protectors directly underneath. The latter are mounted in sets of seven on porcelain plates, and offer a protection against currents up to 500 volts. From these protectors 28-wire asbestos cables run to the switch room, where they terminate in lightning protectors which are fitted on an iron frame and arranged for 56 lines—two cables to each lightning protector. The wires are continued from the lightning protectors to the principal distributor in similar cables.

The lines which are brought into the exchange underground are partly in single-wire paper-insulated cables of the old form and partly in 56 and 112-pair cables of modern construction. The cable heads are arranged in two rows, one over the other, on special iron frames. They are connected with the principal distributor by means of 28-wire or 28-pair asbestos cables.

The principal distributor is constructed of tubular posts connected with each other by flat bar iron, and forms a sort of horseshoe-shaped arbour. A casing of stout sheet-iron, 80 cm. wide and 30 cm. deep, for the reception of the "system" cables leading to the apparatus, runs along the top of the arbour. The terminals to which the cable conductors from the lightning protectors and cable-heads and those leading to the apparatus are connected, are fitted in two rows on ebonite strips which are arranged vertically on the sides of the distributor. The connection of the line terminals with the terminals on the apparatus side is effected by means of asbestos wire which is threaded through oval loops. From the apparatus terminals of the ebonite strips, 42-wire cables are run to the first multiple switchboard.

These cables are insulated with silk and cotton, and consist of 42 single tinned copper wires, 0·6 mm. in diameter. Each wire is first double covered with silk, then 20 are covered over the silk with white, and 20 with red and white cotton, whilst one of the remaining wires is covered with red and the other with blue cotton. Each pair always consists of a white and a red-white wire, or of the red and the blue wires. The wires are stranded up into a cable, which is then covered successively with cotton yarn, prepared tape and a braiding of cotton, and is finally impregnated with a flame-proof compound. Such a cable is connected to a strip of 20 multiple jacks, leaving one pair of wires spare.

There are altogether 37 switchboards or tables, of which the right-wing and centre each contain a single row and the left wing a double row. The multiple boards for the subscribers' lines and for the local and sub-exchange junctions are of the table form, and were supplied by Stock & Co., of Berlin. Ten tables are intended exclusively for subscribers' lines, and of the remainder half are to be used for subscribers' line and half for junctions.

Each half of a subscriber's board has in front 200 drop-indicators, 200 answering jacks divided into five panels, 45 connecting sets (two pegs with cord and weight, one lever switch, and one indicator for the clearing signal) and three answering sets (one microphone and telephone, and one key). The subscribers' lines, arranged on the two-cord system, are distributed to three positions, and each operator is able with this system to assist on the positions on each side of her. The multiple jacks are common to both sides of the table. The answering jacks are fitted in the peg-board, and the multiple jacks in the central part of the table; the surfaces of the strips on which the latter are mounted are roof-shaped, and are furnished with numbers on each sloping side, which can be read from the operator's position on each side of the table.

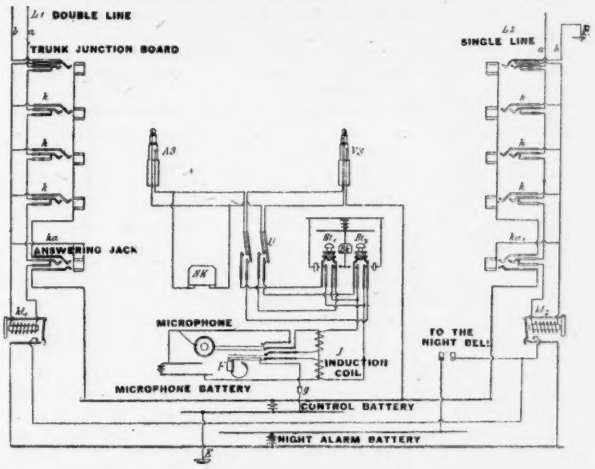
The cables used for connecting the jack-strips of the multiple switchboards, and also the "return" cables for connecting the last jack-strips with the drop indicators contain 63 wires, insulated with silk and cotton; 20 wires are white, 20 red and white, and 20 blue and white, the remaining three being respectively red, blue, and yellow. The blue and white wires are used as test wires. The cables are made up in the same way as the 42-wire cables previously described. There is one cable to each jack-strip, leaving three wires spare. They are placed on the hooks of rack-like supports, which are suspended pendulum fashion from the iron frame of the switchboard underneath the multiple jacks. This plan admits of a compact and easily-inspected arrangement of the cable, and even when the jack space is fully fitted, any cable may be lifted out by hand, either from above or below. The cables are led up from the chasings to the first switchboard through an annex or "dummy" part of the board, which at the same time serves as a writing table for the supervising officer.

The drop indicators are of the usual construction. The armature of the indicator electro-magnet is supported by two screw-points at the back, and carries a long arm, the hooked end of which engages the upper edge of the shutter. If the armature is attracted, the arm is lifted and the shutter released. The shutter, which is also pivotted on screw-points, turns through 90°. The armature has no retractive spring, but falls back into the normal position by its own weight. The adjustment of the amount of play is effected by means of a brass screw passing through the armature. The electro-magnets are arranged side by side in metallic frames in sets of 10. The indicator coil has a resistance of 140 ohms. For night service the indicators are provided with a contact and a spring. When a shutter falls the spring is lifted against the contact, and closes the night-bell circuit. The latter is arranged as follows:—A special self-restoring indicator is provided for each half of the switchboard, which, if any indicator on the board falls, also falls at the same time. The falling of this indicator shows on what board the call has been received. There are altogether 88 of these indicators, arranged in two groups of 24 each and one group of 40. They are placed on the dummy parts of the switchboards. The indicators are large (4 × 5 cm.), and can be recognised without difficulty from opposite ends of the series of boards.

When a fallen indicator is restored on one of the multiple switchboards, the corresponding indicator on the night bell board is at the same time automatically restored. The bell belonging to any night indicator board can be cut out if required.

The operator's set, consisting of the usual breast-plate transmitter and head telephone, may be joined up for use on the multiple switchboard by means of a twin plug and special jack.

The diagram shows the connections for two subscribers' lines (one double and one single) in accordance with the two-cord system



employed. The subscribers are put through by means of special pairs of pegs connected with each other by conducting cords. According to the position of the speaking (listening) key, the subscribers are put through direct, or with the speaking set in circuit. The whole of the lines pass through the multiple jacks of all the switch sections before they reach the answering jacks and indicators, so that when a connection is made, the indicator is always cut out. The system will be best explained by describing the process of putting a subscriber through.

The current from the subscribers' line will pass through the multiple jacks (*k*) of all the sections, then through the answering jacks *ka* and the indicators *kl* either to earth, in the case of single lines, or through the *b* line back to the calling subscriber, in the case of double lines. The shutter *kl* drops, and on seeing this signal, the operator inserts the answering peg A S of one of her cords in the answering jack *ka*, thereby cutting the circuit through the electro-magnet, and if the key U is in the speaking position, establishing a new path for the current through the battery key B *t*, the telephone F, and the induction coil, J, of the microphone circuit to earth, or to the *b* wire of a double line. The microphone battery remains in circuit so long as the operator's set is joined up. When the originating subscriber has given the number of the required subscriber, the operator tests if the wire is engaged by touching the socket of the corresponding multiple jack with the tip of her calling peg, holding her listening key meanwhile in the speaking position. If the line is engaged a click will be heard in the telephone. The electrical operation is as follows:—The sockets of all the multiple jacks belonging to a subscriber's line are connected with each other by a "test" wire. By the insertion of a peg at any one of the operator's positions this test wire will be connected with the negative pole of a test battery whose positive pole is to earth. If now the tip of a calling plug at one of the other positions makes contact with the socket of a jack connected with this test battery, the latter will send a current through the battery key B t_2, the induction coil, J, one-half of the coil of the telephone, F, and the graduator, *g* (of 600 ohms resistance), to earth. If the line is disengaged no circuit will be formed through the jack socket to earth and no click will be heard. To connect the calling subscriber with the required subscriber the calling peg, V S, is then inserted in the latter's jack, and the lever of the speaking key is pushed back (towards the right in the fig.), thereby placing the two lines in immediate connection with each other. The clearing drop, S K, is permanently connected in bridge across the two wires of the peg, A S.

Should it be necessary to call up a subscriber from the exchange a peg is inserted in his jack, the speaking key, U, is pulled forward (towards the right in the fig.), and the key, B *t*, depressed. A magnet giving an electromotive force of 26 to 28 volts supplies current to all the positions. The armature is driven continuously by a small electromotor. The fall of the indicator, B *k*, whose

electromagnet has a resistance of 140 ohms, indicates that current from the generator has passed out.

Special devices have been devised for detecting disturbance on wires. The pole of the generator, which is connected when calling with the *a* wire of the line, is extended to a free multiple board, and is there connected with a metal bar to which also single conductor cords are attached, the pegs of which are cut off so short that when they are inserted in a jack they only make contact with the socket, and do not touch the springs. If there is disturbance on a line, one of these pegs is inserted in the jack socket corresponding to it. Then at all the operators' positions, on making the engaged test on this wire, the rattle of the generator will be audible. This arrangement enables the testing officers, after removing a fault, to call up the exchange on the same wire, and cause the latter to be restored.

The junction wires between Exchange 1 and the other exchanges in Berlin are worked as incoming and outgoing lines—that is, they are used exclusively either in the direction from the central exchange to the sub-exchanges, or from the latter to the central exchange. The somewhat simpler single cord system is applied to these lines. The outgoing junctions are connected with jacks, whilst the incoming junctions do not, like the subscribers' lines, pass through the whole of the multiple switchboards, but are directly connected with the indicators. The exchange has been arranged to take 1,600 outgoing and 1,485 incoming junctions. Each half-switchboard is capable of receiving 45 incoming junctions distributed over three positions, but there are actually only 10 wires connected to each position.

Each junction line is permanently connected with a two-wire cord. The line is led directly to a speaking key. On pushing back the lever of this key the line will be directly connected with the peg, on pulling it forward the speaking set will be placed in bridge across the line. The calling indicator which at the same time acts as a ring-off indicator, and the arrangement of which corresponds to the ring-off indicators in the subscribers' lines is permanently bridged across the *a* and *b* wires of the junction. The test for ascertaining whether the subscribers' line to be connected with the junction is engaged or not, and the connection of the junction with the subscriber's line is effected in the same manner as in the case of two subscribers' lines.

Accumulators are used in the Exchange, and are arranged in boxes of four. The cells—on the Böse system—have an electromotive force of 2 volts each. For supplying the microphones of the Exchange, a common battery consisting of four boxes is used, the cells of which are joined up in parallel. Instead of connecting the microphone separately with the poles of the battery, copper strands are attached to the bars of the switchboard in which the battery leads terminate, and are run along the switchboards. The microphone leads are teed off from these strands. To prevent induction between the various operators' positions, the resistance of the copper strands has been made very low. Each consists of 19 tinned copper wires of 1·5 mm. diameter, and has so small a resistance that no appreciable variation occurs in the currents supplied to the microphones. The ends of the strands, which are well insulated, are looped back to the battery bars.

An accumulator cell is used for the test battery, and one of 2 volts electromotive force is also used for the control clock on the junctions.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"TWO-PHASE" writes:—"I shall be glad if you can tell me whether an electric supply company is liable to be sued for nuisance caused by the vibration at a generating station. So far as I am aware, the Act under which the company is working contains nothing but the ordinary clauses, that is to say, there is no special clause exempting them from liability. May I venture to ask whether the grant of Parliamentary power to supply electricity carries with it the right to occasion a nuisance to those who dwell in the vicinity of the station?"

*** Seeing that a clause is now inserted in every provisional order imposing liability upon every electric lighting company for nuisance, we think our correspondent's company must be so held responsible. By Sec. 77 of the schedule to the Electric Lighting (Clauses) Act, 1899, it is provided that "the undertakers shall be answerable for all accidents, damages and injuries happening through the act or default of the undertakers, or of any person in their employment, by reason of or in consequence of any of the undertakers' works, and shall save harmless all authorities, bodies, and persons by whom any street is repairable, and all other authorities, companies and bodies collectively and individually, and their officers and servants, from all damages and costs in respect of those accidents and injuries." It is thus clear that the common law right of bringing an action for nuisance is not denied to dwellers in the vicinity of a supply station. Moreover, recent cases have shown that the Court of Chancery will not only grant an injunction to restrain the continuance of the nuisance, but, if the injunction is not obeyed, will sequestrate the property of the undertakers upon a motion for committal for contempt of court. The law as it now stands has its origin in the preliminary inquiry before the House of Lords. It may be recollected that Lord Cross's Committee were asked to say whether, in their opinion, those who established a generating station should be rendered liable for nuisance. To this they replied (in the Report):—"With respect to liability for nuisance, they are of opinion that where the site for a generating station is acquired under compulsory powers, and is specified in the Provisional Order or Special Act, the undertakers should not be subjected to any further liability than that which, according to Lord Blackburn, is imposed by the common law in the case of persons exercising statutory powers and duties. On the other hand, where the site for a generating station is acquired by agreement, they think the undertakers ought to be subject to the liability imposed by the common law."

Lord Blackburn thus expressed himself in the case of Geddis *v.* Bann Reservoir (3 A.C., 455): "It is now thoroughly well established that no action will lie for doing that which the Legislature has authorised, if it be done without negligence, although it does occasion damage to anyone; but an action does lie for doing that which the Legislature has authorised if it be done negligently. And I think that if by a reasonable exercise of the powers either given by statute to the promoters, or which they have at common law, the damage could be prevented, it is within this rule negligence not to make such reasonable use of their powers."

THE ELECTRICAL RESISTANCE OF THE HUMAN BODY.*

BY W. L. HOOPER.

SEVERAL years ago while examining the evidence in a case of alleged injury from electrical shock, it became desirable to ascertain the resistance of the human body. An examination of the literature of the subject was most unsatisfactory, different authorities giving values ranging from one thousand to several tens of thousands of ohms; the only rule discoverable being that the better the contact and the more moist the skin, the lower the resistance.

After some preliminary experimenting from which it appeared that the resistance of the body altered with the voltage employed as well as with the character of the contact and condition of the skin, I requested one of my post-graduate students to examine in as large a number of cases as possible the hand-to-hand resistance of the body at all practicable voltages.

Brass rods about ¾ in. in diameter were selected for electrodes; and the resistances were measured first with a Wheatstone bridge and single Leclanché cell and then with milliammeter and voltmeter and battery of storage cells, varying from a few volts to 75 or 100, and sometimes to 125 volts.

With the Wheatstone bridge and cell the resistances were always high, usually from 20,000 to 40,000 ohms; with the milliammeter and voltmeter and a number of storage cells the resistances were always lower, decreasing along an apparently hyperbolic curve until with 100 to 125 volts the results obtained were usually between 1,000 and 2,000 ohms.

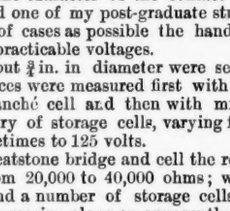
The accompanying diagram shows the form of the curve according to which the resistance varies, but is not to be taken as an actual case.

That the diminution of resistance with high voltages was not due to tighter grip of the handles due to muscular spasm was shown by substituting for the rods heavy pieces of metal resting upon the open palms.

That it is a peculiarity of living tissue was shown by experiments with wet leather, meat and dead animals. Experiments with alternating currents yielded the same results, though with a periodicity of 130, no one was found willing to endure more than 50 volts.

In the search for an explanation of these results a distinct increase in the moisture of the skin on the palms of the hands was observed after experiments with high voltages. It accordingly occurred to us that the diminished resistance might be wholly or in part due to the greater activity of the sweat glands, due to increased flow of blood to the parts under the stimulus of the relatively large currents at high voltages.

If this is the true explanation, then it should take time to establish the conditions necessary for the low resistance observed at high voltages; and if the observations necessary for determining the resistance of the body could be completed in a brief space of



CURVE SHOWING VARIATIONS IN BODILY RESISTANCE.

time, for instance, in one or two hundredths of a second, we ought not then to observe any diminution, or at most a much smaller diminution in the resistance for a given increase of voltage. This hypothesis I have lately tested in the following manner:

In series with the body and battery is placed a non-inductive resistance composed of a series of incandescent lamps and a switch

* Reprinted from the *Tufts Engineer*.

for closing the circuit. To the terminals of the non-inductive resistance is connected a condenser whose charge at any instant will, of course, depend upon the difference of potential between the terminals of that resistance, and therefore upon the current in that branch at the given instant.

In the same way another condenser connected to the terminals grasped by the hands enables us to determine the instantaneous difference of potential between the hands.

Both condensers are connected respectively to the two blades of a double-pole, double-throw switch, one pair of whose jaws are connected to the non-inductive resistance and body, the other pair to two reflecting ballistic galvanometers. This switch is placed a measured distance below the battery switch above mentioned, and both are actuated by a falling weight.

The operation is as follows: the battery switch being open and the double-pole switch being set to connect the condensers to the terminals of the resistance and body respectively, the weight is released, and falling, closes the battery switch, thus establishing the current through the body. After an interval of time, depending upon the distance the weight has fallen and the space between the two switches, the double-pole switch is thrown, thus transferring the terminals of the condensers from the resistances to the galvanometers whose deflections, multiplied by the proper constants, give the potentials at the terminals of the body and the non-inductive resistance respectively. Knowing the value of the non-inductive resistance and the instantaneous value of the potential difference between its terminals, the instantaneous value of the current through the resistance and hence through the body is found. Knowing the current through the body and the difference of potential between the handles, the resistance of the body is determined.

That the indications of this rather complex arrangement of apparatus are reliable is shown by its yielding correct results when known metallic resistances are substituted for that of the human body.

There has not been time at my disposal for anything like an extended series of experiments with the new apparatus, but the results obtained show clearly that the resistance of the body during the first one or two-hundredths of a second after being subjected to potentials of from 50 to 100 volts is much higher than that found after the current has acted for several seconds; resistances below several thousand ohms not having yet been observed.

On the other hand, resistances as high as those found with the Wheatstone bridge and single cell have not been obtained.

It would therefore appear that the decreased resistance of the human body which I have observed with high voltages is at least partly due to stimulated circulation, but that not improbably there are other effects of relatively large currents much more nearly instantaneous in their action, but tending also to reduce the body's resistance.

One evident result of this investigation is to show the utter futility of attempting to determine the amount of current that may flow through a person's body on contact with a high-pressure wire by measuring the resistance of that body with a Wheatstone bridge and one or two battery cells.

THE E.E.R.E (V.) AT MILFORD HAVEN.

The camp at Milford was attended by about 50 men of the Electrical Engineer Volunteers under Lieut. Hodgson. The first party, consisting of the recruits and one or two efficients, went down on Thursday, July 11th, followed by the remainder (all efficients) on the 13th.

The first lot and part of the second were quartered at South Hook Fort, on the north side of the Haven, while the rest were sent to Chapel Bay Fort, on the south side. No work of much importance was done for the first day or two, but the company was taken over the fort, and divided up into sections for working the searchlights, engines and dynamos. On Monday morning, 15th inst., an interesting lecture on the methods of laying mines for harbour defence was given by Captain Simmonds, R.E., the officer in charge of the fort. The men were then detailed for a practice run with the searchlights from 3 o'clock to 9, going on in two reliefs. On Tuesday the first night run took place, from 9 o'clock to 3. On Wednesday morning the efficients of both parties went out to lay submarine mines. This was carried out successfully, three groups of mines with four mines in each being laid across the mouth of the Haven. At night the men were engaged on another night run, for the same length of time. On the following day the mines laid the day before were picked up.

The rest of the day was given to recreation, a cricket match against the Regulars being played in the afternoon, which, owing to lack of time, resulted in an even draw. A smoking concert was held in the evening, to which all the Regulars and the Chapel Bay party were invited.

The concert was a great success, and was much enjoyed by all the men. On Friday morning, the whole detachment was inspected by the officer commanding the Royal Engineers. The drill was performed very smartly, and the men acquitted themselves in a most satisfactory manner. They were then dismissed and inspected at their various stations, a short run being started for this purpose. The evening was spent in packing up, and on Saturday morning, the detachment left Milford, arriving at Paddington at 6.40. Before leaving, Lieut. Hodgson made a short speech, in which he expressed his extreme satisfaction as to the manner in which the work had been carried out.

It is worthy of mention that a company of E.E. Volunteers has been formed at Hong Kong, and that one, if not more, of the members of this company has served at the front, with the first detachment.

It was found that the men in charge of the searchlights suffered from a soreness of the eyes after their work. This was said to be due to carbon dust, but may have been also due to the fact, that the glasses, through which the carbons are observed, were red.

The writer is under the impression that orange-coloured glasses were proved many years ago to be the most suitable for the purpose, and he suggests that the authorities should look carefully into the matter for one cannot be too careful of the preservation of the eyesight in this kind of work.

There is also another point in connection with dress to which attention ought to be drawn.

It was shown last year that the best protection from those rays of the sun which produce sun-stroke is a red lining, which may be quite thin, to one's headgear, the red colour cutting off the injurious rays. A thin red band a few inches wide, running down the inside of the coat or tunic was also suggested for protecting the whole length of the spine. Surely, if there is any real use in these simple additions to the dress of soldier or civilian, they should be adopted, especially if future summers are likely to be as trying as the present one.

AN EVALUATION OF MATHEMATICS.

One of the most striking features of the past six months or so has been the criticism to which our educational methods have been subjected in professional circles. We have not wanted pessimists to say that all our present ideas are wrong, nor optimists to argue that everything is perfect; we have not lacked students to proclaim that higher scientific education is the one thing needed to bring Great Britian back to her old position as an industrial monopolist, nor men of a wider mental horizon to urge that a quantitative knowledge of applied science is not the highest development of man's nature. In non-technical directions the potents are by no means to be neglected. We have been educating the masses for nearly a generation at the expense of the ratepayer; and we find, whether it be *propter hoc* or merely *post hoc*, a steady growth of so-called Hooliganism, a continual increase of inane or pernicious literature, and an ignorant aggressive form of trade unionism which is doing its utmost to bring the country to the verge of disaster. Because Rex *v.* Cockerton has shown that school boards have been exceeding their jurisdiction, new legislation is threatened, although proof that technical instruction is of value to the nation (except as a bait for votes) is conspicuous by its absence. And because the Government for political as well as industrial reasons imposed an apparent restriction on the export of coal, a small section of the community seriously debated whether it should paralyse commerce by a strike, and probably considered itself a martyr to patriotism when it refrained from involving itself and its friends in wholesale ruin. To us, who have to deal more immediately with technical matters, the most noteworthy sign of the times has been a revival of the gospel of mathematics, which has found in its old exponent, Prof. Perry, an apostle of no ordinary competence. In an article on the evils of too early or too narrow specialisation in scientific education,

published in our issue for May 3rd last, we made the bold assertion that the importance of mathematics to the man of science was occasionally over-estimated, as well as being frequently under-estimated; and it is that view of which we have now to attempt a justification.

Among the leading characteristics of mankind is the phenomenon that no abuse or error can ever be combated by the pure philosopher. It is impossible to lead a crusade against excess under the banner of moderation; abstinence is the only cry which appeals to the multitude. Thus the reformer, who in private life may be a man of well-balanced mind, is in his own despite, publicly bound to become the enthusiast, and may deserve or receive the names of faddist and bigot if his cause is unpopular, or if he oversteps the limits set by a cynical or unemotional observer. We cannot help thinking that Prof. Perry has somewhat exceeded the bounds of moderation in his various utterances which culminated in that extremely suggestive address he delivered to the Institution of Electrical Engineers last autumn; but while we say this, we do not desire to impute the least blame to the professor in the matter, because unless his views on the importance of mathematics are exaggerated, he is compelled so to represent them in order to gain his audience.

Art is so long and life is so short that a man cannot be an original investigator, or even a great authority on more than one or two of the subjects with which he is acquainted. In his own branch alone it is impossible for him to have repeated all the work that has been done in days gone by. He must take for granted the results obtained by his predecessors, and must be willing, as he should be proud, to start where they left off. The carpenter begins life with his plane, his saw, and his chisel; he must learn how to use them, and may have a general idea as to how they are manufactured, but it were a waste of time for him to make his own. The plane is the tool of the carpenter; to the plane maker it is, so to say, the reason of his existence. The plane maker is constantly striving to improve the design of his planes; the carpenter is satisfied if they cut, and if he can produce a smooth surface with them as his friends do. Similarly to everybody except the man who intends to widen the science of mathematics, if that be possible, mathematics is a tool, simply a means to an end. Intrinsically, mathematics is of no great value. A sound knowledge of applied chemistry, electricity, or engineering will alone enable a man to earn his living; a knowledge of mathematics alone will make a man little better than an animated slide-rule or calculating machine. A knowledge of applied electricity, engineering, or chemistry alone will never raise a man above a subordinate position. A knowledge of either science fortified by mathematics may make a man a pioneer of world-wide renown. It is often urged that Adams, the mathematician, predicted the situation of the planet Neptune; we venture to say that it was Adams, the physicist and astronomer, who discovered Neptune owing to his skill in mathematics—a fundamentally different conception. Moreover, mathematics being an exact science, a constant employment of it tends to create the belief that every problem can be solved with paper and pencil on inductive principles. Being experimental, most problems in the natural sciences can only be solved in the laboratory by deductive methods. Why is it so difficult to write or lecture to the layman on technical matters intelligibly, yet with absolute accuracy? Why does the scientific witness so often cut a sorry figure in the box? Because in natural science it is so rarely possible to say "It is always so," "It is never so." Because the rules of evidence require modification in the laboratory. Because while one always knows whether he has all the data necessary to solve a mathematical equation, and can be fully confident that the result will be correct if there is no error in calculation; without trial it is impossible to foretell if all the data required in the solution of a physical or chemical problem are in the possession of the inductive reasoner. And because while on the great majority of occasions the results of an incorrectly-solved mathematical problem are obviously ridiculous, and so draw attention to their own inaccuracy; there is no sign that a question in the experimental sciences has been wrongly answered until an actual test of the process brings the fallacy to light.

On the other hand, if it be true that facility in mathematics is not everything in scientific education, it is equally true that ignorance of mathematics is wholly deplorable. The day of purely qualitative work in science has passed, or rather is transitory. We are rightly grateful to the man who first shows us that caustic soda can be made from common salt by electrolysis; but having grasped that fact we inquire, what is the yield? We ask if 40 parts of caustic can be obtained from 59 parts of salt, and if not what becomes of the rest of the sodium, what becomes of the chlorine? Then we ask the output per unit of current, in order to learn the efficiency of the process. And finally we seek to know the output per unit of energy, the cost of the plant, and so on. In fact, if mathematics be simply a means to a end, so also is qualitative—*i.e.*, non-mathematical—work simply a means to an end; and the end is common.

If the arguments we have endeavoured to indicate are not fallacious, it follows that excessive devotion to mathematics during the educational career of any student is to be deprecated. The subjects taught in school and college may be regarded from two different aspects; they may be taught because they are valuable of themselves, or they may be taught simply as mental exercises. Up to a certain point in the training, we hold the latter view, and we believe that those subjects should be selected by the professor which general experience has shown to broaden the juvenile intellect most efficiently. It is a well-known fact that the more a man has studied in his boyhood, the better he can learn in his youth, and the easier he can acquire fresh knowledge when he is adult. It does not seem to matter much what he has studied, because mere exercise of the brain increases its flexibility and receptivity, as exercise of almost any muscle improves the general health, and cures dyspepsia. We claim no originality in employing this parallel: what is the old and German secondary meaning, now almost forgotten, of the word "gymnasium"? If this be true that a subject is taught as an exercise in learning, there does not appear grave reason for the amateur of education to insist on a revolution in those educational ideas which the majority of our older schools and colleges have found to be serviceable. The product of our large public schools and residential universities stands absolutely unrivalled as a polite, cultured, and healthy man of the world, the best raw material of which to make soldier, scholar, divine, or statesman; but his actual education and acquaintance with specific departments of tabulated knowledge are not particularly impressive. Are these institutions then utter failures? It must of necessity happen that inductive methods of reasoning are more hazardous than deductive ones; they must require men of greater mental calibre; and as very few among mankind can ever exhibit genius, while only a minority show talent, it is surely better to adapt our educational methods to suit the majority. The intelligent professor will change his methods to suit an abnormal brain as a matter of course; we do not desire to hinder that purchase of the embryonic Faraday whenever he appears on the market, and we will not haggle over the price. But inasmuch as we have to consider the needs of the majority, we say it is a pity to spend too much time over a subject like mathematics, which regarded intrinsically is only one of the tools the man of science has to handle; or which, in the alternative, regarded extrinsically, fosters a habit of mind that may habitually lead the student to argue from incomplete premises.

Summing up the whole matter in a few words, we would submit that the perusal of such a book as "England's Neglect of Science" is likely to make the reader imagine that Prof. Perry has confused a mathematical education with a training in mathematics. This is no verbal quibble nor distinction without difference. A training in mathematics—that is to say, a working knowledge of and facility in using mathematical methods—is indispensable, absolutely indispensable. A mathematical education, in which everything is subordinated to mathematics, or in which everything is regarded from the mathematician's standpoint, can only produce a mere mathematician: and "a mere courtier, a mere soldier, a mere scholar, a mere anything, is an insipid, pedantic character, and equally ridiculous." If Addison were living now, he might have added more distinctly to his list, "a mere man of science." This is a hard saying, but we shall try to prove its truth in another article.

The concert was a great success, and was much enjoyed

early of too narrow specialisation in scientific education,

EFFICIENCY TEST OF AN 125-H.P. GAS ENGINE.

Gas engines of large horse-power are becoming more and more familiar to engineers, and the success which has attended the introduction of an internal combustion engine producing power on a scale which until recently was thought to belong only to the sphere of steam engineering, has opened out quite a new field of usefulness for the gas engine.

It has always been recognised that the possibilities of gas engines in the direction of thermal economy were greater than those of the steam engine for the reason that the range of temperature in the working cylinder must of necessity be greater than that of the steam engine; at the same time it must not be forgotten that in the case of an internal combustion engine a portion of the work corresponding to that of the boiler of the steam engine plant is done in the cylinder of the gas engine itself, and hence it is not quite fair to the steam engine to compare its work with that of the gas engine on the basis of the proportion of the heat value of the working fluid realised at the fly-wheel.

The gas engine to which we refer has as high a proportion as about 25 per cent. of the energy of the gas appearing as available mechanical energy at the fly-wheel. The Diesel oil engine claims a considerably higher efficiency than this, while the steam engine is pretty far behind the lower of these figures. At the same time, if the efficiency be calculated on the basis of the proportion the heat energy turned into mechanical work bears to that which is theoretically possible to turn into work having regard to the range of temperature through which the working fluid acts, it will be found that our old friend the steam engine is not by any means so far behind in the race for efficiency as would appear at first sight to be the case.

It must not be forgotten, however, that after all the only definition of efficiency, which will stand the test of sordid commercial investigation, is the ratio $\frac{\text{what you get}}{\text{what you pay for}}$. Clearly, while the numerator to this fraction may be a definite one, namely, available mechanical energy, the denominator must of necessity be made up of a number of factors if this definition is to apply fairly to various types of motor. Fuel consumption alone is not all that one has to pay for in the production of power. The cost of repairs and renewals, the cost of maintenance and superintendence, all have to enter into the equation, and must not be lost sight of.

The gas engine referred to in the title is one of two 125-H.P. Westinghouse gas engines installed at the Merchant's Electric Lighting Association at La Fayette, in the State of Indiana. The engine is of the vertical three-cylinder type, and works on the Otto cycle. The governing is attained by varying the mixture of gas and air without in any way affecting the quality of the gas, and a working impulse is given at two-thirds of every revolution whether the load is heavy or light.

This engine was tested in 1899, and the results are published under the same title as above in the *Transactions* of the American Society of Mechanical Engineers, vol. 21, p. 396. It was then stated that further tests were to be made, and it is to these further tests that reference is made in a paper by Mr. C. H. Robertson, which was read at the Milwaukee meeting in May of this year of the American Society of Mechanical Engineers. The tests are very carefully made, and include a number of interesting measurements and determinations which are not usually met with in tests of this character.

Particular attention may be drawn to the ingenious method adopted by Mr. Robertson for showing the speed fluctuation due to sudden changes in the load. The apparatus is very similar to that which was used by Mr. Ransom in obtaining the results which he brought before the Institution of Civil Engineers in the year 1889, vol. 98, the fundamental principle being the vibration set up by a tuning fork, the rate of which was determined and found to be practically constant. It was found that the maximum variation under full load was $1\frac{1}{2}$ per cent. below and above normal, or a total variation of 3 per cent. Measurement was also made of the exhaust gas temperature by means of a Le Chatelier pyrometer. From the indications of this pyrometer it would appear that the exhaust temperature varied from 1,400 to 1,800° F., which certainly seems rather high. The gas used was natural gas, the heating value of which was taken as 969·85 British thermal units.

The thermal efficiency of the engine, or the ratio of the thermal equivalent of the brake horse-power to the heat value of the gas used per brake horse-power reached a maximum of 23·24 per cent. at full load of about 138 I.H.P., which is certainly a very satisfactory result. The efficiency calculated in the same way sank to 16·18 per cent. at 99 I.H.P., and to 10·76 per cent. at 54 I.H.P.

The following table gives the main results obtained during the tests and will be found of interest:—

Résumé of data.	Six-hour test.			Five short tests.	
	Average of test.	Lowest of test.	Highest of test.	Lowest of tests.	Highest of tests.
Indicated horse-power	113·12	51·69	142·37	18·57	164·22
Brake horse-power	92·19	30·81	122·86	0	143·17
Electrical horse-power	87·12	28·77	115·96	—	—
Frictional horse-power	20·93	14·72	31·01	17·08	21·05
Mechanical efficiency of engine (per cent.)	79·39	57·38	89·05	0	87
Standard gas per indicated horse-power-hour	10·62	9·70	13·99	9·87	25·8
Standard gas per brake horse-power-hour	13·69	11·29	24·37	11·51	—
Standard gas per electrical horse-power-hour	14·49	11·97	26·10	—	—
Thermal efficiency of engine (per cent.) B.T.U. equal to B.H.P. ...	20·05	10·76	23·24	—	22·8
B.T.U. in Gas.					
Thermal efficiency of plant (per cent.) B.T.U. equal to B.H.P. ...	18·04	10·05	21·92	—	—
British thermal units per I.H.P. per minute	171·66	156·79	226·13	—	—

SMOKY FURNACES, AND HOW TO AVOID THEM.

By W. H. BOOTH.

I.

It has been remarked that from the days of Watt forward to the present day the prevention of smoke has been a constant study of engineers and others, and has never been satisfactorily attained. We read much of chemistry of combustion, of the necessity for air, and of the temperature of ignition, but we hear little of forms of furnaces or of suitable arrangements for leading the gases away from the furnace.

No single remedy will serve in an ordinary case. The air necessary for combustion is stated as 12 lbs. per pound of coal. This should rather be stated as the amount of air that will combine, as regards its oxygen, with 1 lb. of coal, but it is extremely improbable that it represents the quantity of air to which, given perfect mixture and the necessary temperature, it would be possible to reduce the supply, for the law of chemical mass action steps in and tells us that probably carbon and hydrogen can both exist in the uncombined form in the presence of free oxygen if there be also present a sufficient quantity of water vapour and carbon dioxide, *i.e.*, of already oxydised hydrogen and carbon, that, in fact,

On the other hand, if it be true that facility in mathe- we shall try to prove its truth in another article.

perfect combustion demands an excess of oxygen, and that the nominal minimum of 12 lbs. of air should not be attempted.

If we examine systems of smoke prevention we shall see that they resolve themselves into two classes. In the one class there is admission of air above the fire to burn the hydro-carbon gases evolved from the fuel. In a second there is the use of masses of highly heated firebrick placed beyond the fire to absorb heat when the fire is at its maximum temperature, and to give it out to the gases when the fire is cooled by a fresh charge of fuel. Both methods are correct in principle, but do not form complete systems. The one recognises an insufficiency of air at the period when the openings of the fire are choked up by fresh fuel; the other recognises that the furnace gases are too cold, and attempts to add heat to help them to burn. Both may be successful when other essentials are present to give a complete system. The principle of air admission at the right time, in the right place, and in proper form was carried out by one J. K. Broadbent for many years. His apparatus consisted of a set of weighted louvre openings in the fire-door, which were so connected by a chain to a piece of simple clockwork that when the door was closed, after firing, the louvres were pulled open, and then by their weight they actuated the clockwork, which had a verge escapement and allowed the louvres to shut gradually, thereby approximating the air supply to the volume of the gases distilled off the fuel. The device was good, and it was based on good principles. It was often successful, and sometimes effected a small economy of fuel. It was difficult to make it act well when the draught was poor, for in such cases the amount of air drawn through the louvres was insufficient, and a velocity of draught of not less than 30 ft. per second seemed to be necessary to successful action. The second device, that of masses of firebrick placed beyond the furnace was so far correct that it embraced the transference of surplus heat from one period of the furnace to another and less heated period. The system had the merit of simplicity and easy application, so that after a few years "supplying half a load of firebrick for £20" the proprietor was able to retire to classic Blackpool, whereas those whose apparatus required castings or mechanism or alterations to furnace fronts were probably less successful in the worldly and vulgar sense.

Besides these two named systems there were the multitude of steam-jet men. The merit of the steam jet was that it helped a bad draught and enabled a flow of air to be maintained above the surface. But there was sometimes a peculiar action from introducing the merest breath of steam —not a jet in the ordinary sense of the term—as small an escape as one could admit the small steam-valve to give. This effect where the steam was admitted just over the door of a Lancashire boiler furnace was to cause a sluggish fire to leap into brisk full flame, an action I have never had explained, but that may have been connected with the claim made that, except in presence of water vapour, hydro-carbons will not burn. There are certain conditions under which smokeless combustion is not practicable. One of these is a vibratory draught. This phenomenon is really a rapid succession of explosive combustions of the furnace gases and an equally rapid extinction. It is usually curable by a further admission of air, and it is often caused by apparently very trivial forms of flues; square bends where round corners would be better, the lack of a mid feather wall, or some equally simple cause. Attention is drawn to these various points to enable an idea to be formed of the very narrow limit between success and failure in all the attempts at smokelessness that has come under my notice. Thus, for example, there were two boilers alike in every particular except that one had a water-pipe built right up to the bridge wall. In the other it was absent. The boiler with the pipe smoked, the other did not smoke. The smoky boiler was cured by bringing the bridge back clear of the pipe. This action of cross water-pipes is common and usual and what may be expected. The smoke or green gas from freshly stoked coal is a very impure gas, and, as may be observed in an ordinary house fire, will flicker into flame and become extinguished indifferently. The flame in a boiler flue is similarly but indifferently alight. It will extinguish with slight shock, and this shock is given to the flame by every cross water-pipe.

Clear evidence of the action of cross water-pipes is given by boilers with and without them. A perfectly plain boiler will always be found much cleaner and more free from soot than a boiler that has cross pipes. This is no theory, but the result of thousands of observations of this and similar causes and effects.

In the successful cases of smoke prevention that are sometimes encountered, observation will show, in the case of Lancashire boilers, that the draught is good, the air admission is well regulated, ash pit dampers perhaps being applied in addition to flue dampers, and that there is uninterrupted space behind the bridge wall in which the gases complete their combustion. A study of such a furnace will show that the fresh or secondary air admitted at the door is drawn over the whole length of the furnace and well mixed with the gases that pour off each unit of area of the grate. The resultant volume is thus well mixed and fairly homogeneous when it arrives at the bridge, and is also at a temperature sufficient to burn, and it does burn in the space beyond the bridge, and smokeless, or practically smokeless, combustion is the result. But this end is only attained in exceptional cases. What is wanting to assure the process in every case? Even the model examples occasionally fall from grace and produce smoke. There can be but one reason, and that is that the coal gases being impure and difficult of ignition and combustion except in favourable circumstances, some determining factor is absent. The one factor that is left to the boiler itself to fix is that of temperature. No one ever pays any heed to this. The inside of the boiler contains boiling water—therefore 'tis hot. Any idea of comparative temperatures rarely enters the mind of boiler designers. That a boiler at 350° is really a remarkably chilly body is not to be thought of, and yet of course this is so. The boiler is 650° colder than the minimum temperature necessary for gaseous combustion, and there are ample evidences that the work of a boiler is mostly done in the furnace on the first few inches of fire tube or the first of the water tubes; that, in fact, the temperature of the furnace gases is reduced below the necessary point before they have the chance to ignite. In the presence of this fact it is difficult to understand the constant cry that smoke cannot be prevented, or that, whereas the chemistry of combustion is so much talked about, this same chemistry cannot be applied in practice.

My contention is, and long has been, that few genuine attempts have ever been made to apply the principles of chemistry to practical combustion. One or all the essentials have steadily and persistently been neglected, and none more so than that most essential one of temperature. This essential must be present. An odd one of the others might perhaps be omitted without any serious results if only that of temperature be present.

In what follows I propose to deal with a few furnaces as we find them, with a view to show how far they are constructed upon correct lines and in what points they fail, or may fail, to effect perfect combustion.

Such an examination may well commence with the old-fashioned cylinder boiler, underfired, such as was familiar to James Watt, and that is still used in a modified form so largely in America and in collieries and ironworks. The longitudinal section of the furnace was very much as in the annexed sketch (fig. 1).

In Watt's days there was no door, merely a heap of coal as per the dotted line. In such a furnace as this there are present most essentials for smokeless combustion. First, there is the production of most of the volume of hydro-carbon gas at the front end of the furnace. It is there produced from the heap of coal, that serves as a door, by a process of gradual distillation spread over a considerable period of time. As produced, it is mingled with fresh air, which leaks in through the interstices of the heap of coal, and the admixture is probably very perfect indeed. The mixed gases then pass over the extreme length of the furnace exposed to the radiation of the hot fire of coked fuel, which is itself now giving off little or no hydro-carbon gas. There is thus the possibility that by the time the gases reach the bridge they are heated sufficiently to combine. It will also be observed that when the coked or partially coked heap of coal upon the dead plate is pushed back and spread upon the fire, it will obtain its secondary air to consume such gases

as still remain undistilled by leakage through the heap of fresh fuel during the few minutes that elapse before this begins to give out much gas.

The arrangement is, so far, altogether good in principle, though skill is needed in the fireman to enable him to arrange the coking so as to produce the best amount of air admission. The heated gases should now be well ignited as

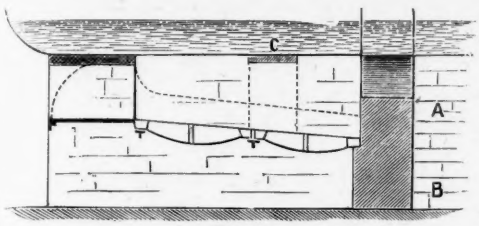


Fig. 1.

they pass over the bridge and should complete their combustion in the space beyond the bottom of which space is sometimes, as at A, and sometimes lower, as at B. Formerly, the boiler would be placed 16 to 18 in. above the grate surface, but now from 24 to 30 in. would be considered better practice. If this type of furnace is so good, where does it fail? It fails to be perfectly smokeless in some cases because of its failure to secure adequate temperature. This may be brought about by the cold roof of the furnace, which is, of course, the plate of the boiler bottom. This, at a temperature of about 220° and upwards according to date, the lower limit coinciding with Watt's time, is 2,000° or so below the fire temperature, and has a most chilling effect, and this same effect continues right along the combustion chamber. The furnace sides are brick, and, so far, help the furnace, which would assuredly be smokeless if its roof also were of fire brick. As a proof of this may be cited the chain grate known as Juckes furnace, at one time much used in the Halifax district for underfiring Lancashire boilers. The Juckes furnace always had a very long brick arch thrown over the front end of the furnace to protect the end of the boiler, and to assist in coking the fresh fuel as it travelled in on the moving grate. The Juckes furnace was thus of distinctly coking type, and it did very well, though possibly it had the fault of all coking stokers, that of admitting air too freely through the less thickly-covered bars at the back end of the grate—a fault, however, that was mitigated in this furnace by the check of the bridge which held back the fuel and skimmed it off the retreating grate, so heaping it upon the rear end of the grate surface, otherwise too thinly covered. Unfortunately the underfiring of boilers is held to be unsafe, but as regards efficiency of combustion, under-firing did afford room for good machine stokers of the Juckes type, than which nothing better has ever been introduced, and that where heavily worked and liable to smoke, could probably be made smokeless by a second arch of fire brick thrown over the fire as shown dotted at c in fig. 1, as a means of preventing a part of the chilling action of the boiler. Apart from the cold roof of this furnace this is the system to be followed for smokelessness, and so far as it is departed from in modern boilers, just so far will the use of bituminous fuels entail fines, or the gentle attention of Sir W. B. Richmond's artistic photography.

(*To be continued.*)

THE POLYPHASE INDUCTION MOTOR FOR GENERAL POWER SERVICE.

The contributions to the subject of polyphase working in general, and that of the induction motor in particular, have recently attracted much attention, and whether the frequency of these contributions indicate the possibility of a general development in polyphase working in this country or not, we consider it a step in the right direction to keep up the discussion of so important a subject. There is undoubtedly much misunderstanding in the minds of many respecting the characteristic principles and applicability of the induction motor, and it is refreshing to read what the well-known exponent of alternating current working, Mr. Ralph D. Mershon, has to say in a recent number of the *Electrical World and Engineer* about some of the features of the working of induction motors, which some engineers dispute or ignore. Although an able advocate of polyphase working he presents, in the article to which we refer, his case with fairness and without bias, and in no single instance manifests that partisan spirit which we so often encounter in discussions of this kind. The purpose of the article is to show that a variety of misconceptions and erroneous conclusions have from time to time been brought forward when comparing the working of the polyphase induction motor with that of the direct current motor, much to the disadvantage of the former, and whilst acknowledging that conditions exist which can be better met by the direct current motor, especially the series motor, than by the induction motor, he claims that for general power service the induction motor has a field of its own, and possesses considerable merit. In his opinion, many of the objections brought forward against the induction motor are imaginary, and have been proved so in practice. In cases where power is required in small amounts at numerous points, and generally for work requiring practically constant speed, the induction motor will hold its own.

The fallacies which he refutes are:—(1) The inefficiency of the starting torque; (2) absence of speed control; (3) disturbance, at starting, to voltage of supply; and (4) low power factor. Before dealing with these factors it may be well to remark here that the production of an ideal machine is largely a commercial question, and a matter of pounds, shillings and pence; refinement in design may be obtained in any system if the cost of the motor be not considered. Inefficiency of starting torque has been proved by practical experience with induction motors to be a fallacy, and in ordinary cases is quite as good as that of shunt-wound motors; any value of starting torque within reasonable limits, *i.e.*, up to two or three times the full-load running torque, may be obtained by designing the induction motor for the special work for which it is required. In this respect it is probably superior, and not inferior, to the shunt-wound motor.

The question of speed control is a matter of importance in some special cases, and experience shows that as regard this question the action of an induction motor is the same as that of a shunt-wound motor when both are supplied with a rheostat in the armature circuit, and there is little to choose between them. When it is necessary to maintain a constant speed—any one out of a number of different speeds—with varying torque, the induction motor is usually wound so that the number of poles may be varied by means of a controller; for higher speeds the number of poles is diminished, and increased when a lower speed is required. To enable the shunt-wound motor to work under these conditions, it is customary to instal two or more supply circuits of different voltages, *i.e.*, to vary the voltage of supply to obtain the proper working conditions.

The objection which has been raised against the induction motor on account of the disturbance, at starting, to the voltage of supply is probably due to the fact that an induction motor with a "squirrel-cage" secondary, and having, therefore, no moving contacts and no starting resistance in the secondary, will, under some conditions, produce considerable disturbance if started under load or run below speed, since the power factor of such a motor when so operated is not so high as that of a motor under rheostatic control, although at full speed it may be as high, or higher. But induction motors with rheostatic control in the second circuit start identically as shunt-wound motors, and produce but little more disturbance than they do. This refers, of course, to modern induction motors designed to have a power factor of 90 per cent. It must, however, be admitted that on all systems there will be a momentary disturbance of the voltage of supply when a sudden demand is made for energy; but just as it would be absurd to condemn continuous-current motors because some engineers recommend a separate and distinct source of supply for crane work or other intermittent work in which the demand may be both sudden and great, to avoid disturbance to the other loads, so the objection to the induction motor on these grounds is of little moment.

to the flame by every cross water-pipe.

The power factor of an induction motor being less than unity, and in some cases fairly low, has been made the bugbear to its introduction. As with other factors, the value of the power factor is very largely a question of design and suitability of the motor for the work to be done—*i.e.*, the size of the motor should be chosen so that it works as near full load as possible under average working conditions, and there is no doubt that the power factor of an induction motor can be controlled within wide limits by careful design. American manufacturers now undertake to supply induction motors with power factors of 0·9 to 0·92 at full load, and we believe that a power factor as high as 0·96 has been realised. Furthermore, the power factor has in general nothing to do with the efficiency of an induction motor; in fact, it is an easy matter to design an induction motor with a low power factor and a high efficiency, or *vice versâ*. Then again, the customer's meter registers only the true power, so that a low-power factor can affect him only as it may affect the regulation of the circuit feeding the premises; a low-power factor, however, introduces a condition of working which the station engineer cannot ignore, since the drop and losses in the lines, transformers and generators are greater than they would be with unit power factor. There are two general cases which may be considered; (*a*) plants supplying a motor load exclusively, and (*b*) plants operating on a combined lighting and power service. We shall certainly not be unjust if we assume a value of 0·8 for the power factor of the induction motor, and for exclusive-power service this means that if the motor requires an amount of power represented by 100 amperes at a power factor of unity, then the amperage for a power factor of 0·8 will be $100 \times \frac{1}{0{\cdot}8}$, or 125 amperes, and the loss in the lines, transformers, &c., correspond to 125 amperes instead of 100 amperes, and the efficiency and capacity of the system are thereby impaired. For combined lighting and power service the power factor of the circuit as a whole is greater than that of the induction motors alone, as shown by the following example:—Let us suppose that the lighting load is represented by 100 amperes, and that if the power factor of the motors were unity, that portion of the load would also be 100 amperes. With a power 0·8, the motors would require 125 amperes. In fig. 1

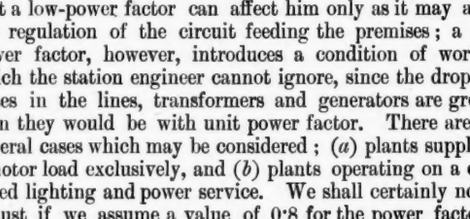


Fig. 1.

let A B represent the current of 100 amperes required for the lamps, and since the power factor of the lighting circuit may be taken as unity, the current is in phase with the pressure of supply. The current of 125 amperes for the motors, however, lags behind the pressure of supply by an angle, the cosine of which equals 0·8. Let the angle B A C denote this angle, and the line A C represents the motor current in magnitude and phase. The resultant of A B and A C is A D, the magnitude of which may be found graphically, or from the expression—

$$A\,D = \sqrt{(A\,B)^2 + (A\,C)^2 + 2\,(A\,B)\,(A\,C)\cos\theta}$$

and its position relatively to A B from the formula

$$\tan\alpha = \frac{A\,C\sin\theta}{A\,B + A\,C\cos\theta}$$

In the case under consideration the resultant current is 213·6 amperes, and not (125 + 100) or 225 amperes, and the resulting power factor 0·936 instead of 0·8. These results are not so extravagant as some engineers would make out. Of course, the times when the light load is small must also be taken into account, but in no case will the power factor of the complete circuit be less than 0·8. Mr. Mershon also considers the use of synchronous motors and condensers as means for raising the value of the power factor, and as he points out the use of either makes the system more complicated. Commercial condensers cannot at present be considered reliable, and it is doubtful whether the introduction of synchronous motors can be considered good engineering. They may be utilised as regulators, but they themselves require close attention whilst working, and if the field excitation is not exactly that required for the particular condition of working, the resulting disturbing influence may be more of a curse than a blessing. The induction motor considered as a piece of electrical apparatus has much in its favour and little to condemn when the flexibility and adaptability of the induction motor are compared with the same qualities of the shunt wound motor for general power service, and we shall be surprised if the induction motor has not a great future before it.

CURRENT SPECIFICATIONS.

LXXII.—GRAVESEND LIGHTING.

Summary.

Extent of Tender.—Eleven sections, comprising the whole plant necessary for an electric lighting and dust destructor plant excepting buildings. Tenders for one or any number of complete sections will be considered.

System Proposed.—Three-wire low tension system, with accumulators for lighting and direct current 500 volts for traction.

Number and Size of Boilers.—Three of water-tube type to be provided, each to be capable of evaporating 6,400 lbs. of water per hour with natural draught from 85° F. One boiler to be specially constructed for use with a dust destructor.

Working Pressure.—135 lbs. per sq. in. in engine steam chest.

Superheater.—Superheater to be provided to raise temperature of steam to 500° F.

Economiser.—To be of Carter or other approved type having heating surface equal to 80 of Carter's 6-ft. pipes.

Water Softener.—One to be provided, capable of reducing the hardness in 2,000 gallons of water per hour from 20 per cent. to 2 per cent.

Steam Dynamos.—Three to be provided, each 200 kw. capacity, speed not to exceed 400 revolutions per minute.

Type of Engine.—Left optional with tenderer.

Range of Governing.—Not to exceed 2½ per cent. when full load turned on suddenly. Hand adjustment to be provided.

Voltage of Dynamos.—A shunt machine to give any voltage at full load between 470 and 500 volts. A compound machine for traction to give 500 volts at all loads.

Specified Temperature Rise.—Not to exceed 6·5° F. taken 15 minutes after stopping a six hours' full load run. If temperature rise exceeds 70° F. machine may be totally rejected.

Balancers and Boosters.—To consist of four machines, two balancers and two boosters. Balancers to deal with an out-of-balance current of 150 amperes and boosters to raise 100 amperes 110 volts. Speed of set not to exceed 850 revolutions per minute.

Traction Booster.—To boost 280 amperes from 500 to 600 volts. Speed optional.

Switchboard.—To be standard type, suitable for combined lighting and traction station on the low-tension direct-current system.

Arc Lamps.—Twenty-seven 16-hour Brockie-Pell, Crompton-Pochin or other approved type of arc lamp to be provided, to be run nine in series across 470-volt circuit.

Underground Cables.—To be of type and length specified, laid in wood troughing, filled in with bitumen. Insulation to be specially prepared paper or other approved material. Detail prices to be given as required by specification.

Accumulators.—To give 70 amperes for nine hours, or 300 amperes for one hour voltage at end of discharge not to be less than 500 volts.

Travelling Crane.—Hand traveller to lift 10 tons suitable for span of 38 ft.

Dust Destructor.—To consist of four cells, each capable of dealing with 10 cwt. of ordinary house refuse per hour.

Date for Completion.—Crane, dust destructor, well and water-lifting apparatus in four months; boilers, pipes, steam dynamos, boosters and switchboard, in five months; cells, meters, underground mains and arc lamps, in six months.

Penalty for Late Completion.—One per cent. of contract price for section late per week.

Terms of Payment.—80 per cent. as work proceeds on engineer's certificate, 10 per cent. on completion, 10 per cent. at end of 12 months.

Period of Maintenance.—12 months from date of completion.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages to be paid to Workmen.—None.

Amount of Surety Demanded.—15 per cent. of tender sum for each section.

Arbitration Proposals.—See comments below.

Date for Receipt of Tenders.—July 30th, 1901.

Mr. W. H. Trentham, M.I.E.E., as consulting electrical engineer to the Corporation of Gravesend, is responsible for the preparation of this specification.

the characteristic principles and applicability of the induction

the objection to the induction motor on these grounds is of little moment.

The technical portions are on the whole clear statements of what is required. It will be noted, however, that one of the three boilers is to have extra large drums to render it suitable for use in conjunction with a dust destructor, and that while the two ordinary boilers are to be suitable for 160 lbs. sq. in. working pressure, this special boiler must be capable of working at 180 lbs. sq. in. pressure.

The fuel economiser is specified to be either of the Carter type, or else to have a heating surface equal to that of one of their standard sizes.

One of the sections provides for the supply of a four-cell refuse destructor, each cell of which is specified to be capable of dealing with half a ton of ordinary house refuse per hour.

The steam dynamos are arranged in two sections, the engines with combined bedplates forming one section and the dynamos with the balancers and boosters another. Three 200-KW. sets are required, and the specification is very open, the limit of speed is to be 400 revolutions per minute, but there should be no difficulty in quoting for any of the standard types of enclosed engines on the market. The dynamos are required to work as shunt machines at full load at any voltage between 470 and 500 volts; the compound winding which is required to render them suitable for traction work being arranged to maintain a constant pressure of 500 volts at the dynamo terminals. A special tramway booster is to be supplied to raise the pressure of the current supplied for tramway work from 500 to 600 volts.

It is stipulated that the contract price for the accumulators shall include the cost of maintenance for the first *two* years, and a price is to be stated at which the contractor for this section will undertake annual maintenance for a further period up to 75 per cent. of the specified output. We do not approve of the principle of giving one period for maintenance in the general conditions for the whole contract and afterwards doubling the period in the case of particular sections, particularly when, as in this case, an annual charge for maintenance for a further period is to be stated.

In view of the present congestion of work in the engineering trades the periods given for the completion of various sections of the work are very short, but it is only fair to say that in the clause in the general conditions dealing with this subject it is stated that strikes, an unavoidable accident to manufacturer's machinery, or other cause beyond the reasonable control of the contractor shall form legitimate reasons for the extension of the time which must elapse before penalty for late completion commences.

One clause places the whole of the liability for accidents occurring during the carrying out of the work upon the respective contractors, and another imposes a curious modification of the arbitration clause. It states that if a dispute involves a less sum than £100 it shall be decided by the engineer without right of appeal, but if the sum involved is more than £100 it shall be referred to an independent arbitrator in accordance with the provisions of the 1889 Arbitration Act. It is almost needless to say that we do not consider such a course of action just. Whether the amount involved in any one particular dispute is less or more than £100, we hold that it ought to be within the powers of either party to appeal to an independent judgment, and we protest against the attempts constantly made to limit this right, and at the same time set up the engineer as sole arbiter in cases of dispute. In maintaining the position we have taken up, we believe that we are increasing rather than the reverse the moral power of the engineer, and that the adoption of a perfectly unlimited arbitration clause will reduce the actual number of appeals made to its decision in possible cases of dispute.

Glasgow.—The annual dinner of the Tramways and Light Railways Association has been fixed for Wednesday, September 4th, at the Windsor Hotel, Glasgow. On 3rd inst. the Corporation will receive the members of the Engineering Congress, and a ball has been arranged for the 5th inst.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

13,851. "Improvements in or applicable to electric motors and dynamos and other like apparatus." F. MILLINGTON. July 8th.

13,881. "Improvements in inductance and induction coils." H. SHOEMAKER and G. P. GEHRING. July 8th. (Complete.)

13,934. "The application of an enamel for insulating or decorating or the combination of both to covers and bases of switches, ceiling roses and cut-outs." M. H. GOLDSTONE and J. H. WARD. July 9th.

13,940. "System of vacuum tube lighting and dynamo machine for use in connection therewith." W. L. WISE. (The Moore Electrical Company, United States.) July 9th. (Complete.)

13,947. "Improvements in and connected with electrical water heaters." H. M. HILL. July 9th. (Complete.)

13,956. "Improvements in electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. B. Potter and C. D. Clark, United States.) July 9th. (Complete.)

13,957. "Improvements in controllers for electric motors." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. B. Linn, United States.) July 9th. (Complete.)

13,958. "Improvements in electric indicating instruments." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED (C. D. Haskins, United States.) July 9th. (Complete.)

13,984. "Improvements in or relating to electrical storage batteries." H. K. P. BARHAM. July 9th. (Complete.)

13,986. "Improvements in electric cables." G. G. M. HARDINGHAM. (Felten & Guilleaume, Carlswerk Actien-Gesellschaft, Germany.) July 9th.

14,049. "Improvements in trolley heads for electric tramcars." J. H. F. BALE. July 10th.

14,059. "A form of rotary synchronous alternating current motor." G. B. BATTEN. July 10th.

14,086. "Improvements in the construction of electrodes for accumulator batteries and in moulds therefor" R. J. GULCHER. July 10th. (Complete.)

14,102. "Improvements in electrical indicating apparatus." H. T. HARRISON. July 10th.

14,110. "An improved method of automatically regulating the flow of liquids, gases, electricity, chemicals and powders." W. P. MILES. July 11th.

14,235. "Improvements in or relating to electric signalling or whistling devices." S. A. BROWN and J. W. POINTS. July 12th. (Complete.)

14,236. "Improvements in the working and controlling of electrically-driven cars." SIEMENS BROS. & Co., LIMITED, and A. SIEMENS. July 12th.

14,237. "Improvements in and connected with electric arc lamps." J. O. GIRDLESTONE and C. F. G. THORKELIN. July 12th.

14,295. "Wire guard for electric arc lamps." J. W. RICHARDS. July 13th.

14,319. "A new or improved arrangement for producing the voltaic arc between metal electrodes." J. VON KOWALSKI and I. MOSCICKI. July 13th.

14,328. "Improvements in electrical machines." H. M. ABEL. July 13th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

21,661. "Improvements in cut-outs and switches for high potential electric circuits." The British Thomson-Houston Company, Limited. (E. M. Hewlett.) Dated October 30th, 1899. The object is to minimise arcing in high-potential circuit breakers. The terminals are enclosed in insulating air-tight tubes, and on the formation of the arc the expansion of the contained air blows out the moving terminals with great rapidity. In the application of the invention to magnetic cut-outs, terminals carry spring contacts adapted to be bridged by rods and cross-piece, the rods sliding in insulating tubes. The cross-piece is in the form of a piston, and a dashpot checks the violence of its movement. The cross-piece and its contact rods are held up against the action of a spring by a pawl engaging with trip mechanism which is operated by the core of the series coil. In hand switches the trip mechanism is operated by a suitable handle, or it may be controlled by thermal appliances. 9 claims.

21,662. "Improvements in electric arc lamps and magnets therefor." The British Thomson-Houston Company, Limited. (G. E. Stevens.) Dated October 30th, 1899. An enclosed arc clutch lamp is provided with an improved lower carbon and enclosing globe holder, a means for holding up the upper carbon in trimming, and a ventilated differential regulating ironclad solenoid. The lower carbon is held by three conical segments which are forced against it in opposition to an expanding spring by a conical sleeve in a cup on a supporting yoke. The sleeve carries the enclosing globe on packing, and the globe is pressed down on the sleeve by a coiled spring in a cap which is screwed on the cup. An opening in the yoke, through which the carbons are renewed, is closed by a spring-pressed pivoted plate. A clutch is carried by a central tube and with the upper carbon is held up during trimming by a latch applied by hand; the latch is weighted to disengage automatically when the tube rises on current being supplied to the lamp. The tube is guided in renewable plates, on the solenoid bobbin. This bobbin consists of a copper tube and iron ends placed on a non-magnetic tube, which is expanded at the ends to hold the parts together. A large metal bobbin is held against the upper end by an iron ring secured by screws and lugs to the lower end. The upper end and the ring are also connected by two iron plates attached by screws. The series and shunt coils are wound on insulating material in the inner and outer bobbins respectively, leaving a space between them, through which and openings in the ends air passes to keep the shunt coil cool. The upper end is attached to the head of the lamp, which carries notched supports for insulators carrying a coiled wire series resistance, and has sockets carrying two side tubes supporting the yoke. Above the clutch the side tubes are connected by two horizontal plates, separated by an air space. An outer globe is supported by a lower yoke on rods which slide in the side tubes and are held up by a latch. 19 claims.

21,663. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (R. Fleming.) Dated October 30th, 1899. A clutch consists of two curved jaws, grooved to fit the upper carbon, and pivotted eccentrically at their outer ends between two plates which are clamped on a central regulating tube. The regulating tube is attached to a core within series and shunt coils acting differentially and to an insulated head, connected by a dash-pot and by a helical spring with the top of the lamp frame, part of the weight being thus supported. The clutch jaws release the upper carbon when they descend upon a stationary plate, but, in order to render this action prompt, an auxiliary shunt

as means for raising the value of the power factor, and as he points out the use of either makes the system more compli-

solenoid is just previously connected between the lamp terminals by a silver contact on the head of the regulating tube descending upon a stationary contact, and the solenoid then pulls down a core attached to the head. The contact is a pin supported by a spring in a socket, and, in case of failure of the lamp, permits further descent of the silver contact until this bears on a fixed contact, closing a circuit through a resistance across the lamp. The lamp frame consists of side pieces formed on a plate and stepped inward twice next the top, where they unite and are screwed on a hanger, a plate being interposed. The steps provide for the mounting of a series resistance or inductance as may be required. The plate supports the lamp terminals and a short-circuiting switch. The sides have four internal lugs, to be attached by screws to vertical lugs on the ends of the bobbin of the coils, the upper end of which carries the auxiliary solenoid. The sides have external extensions to fit a casing, and to carry a bridge with the contacts. The sides also support tubes carrying the lower carbon holder, and containing rods supporting an outer globe. The plate on which the side pieces are formed carries a layer of non-conducting material, and a lower plate to keep the upper part of the lamp cool. 19 claims.

21,664. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (C. E. Harthan and G. E. Stevens.) Dated October 30th, 1899. An arc enclosing globe is held up to a cover plate by packing in a recessed holder, which is partly conical, and rests of metallic bushing in a slot in a yoke. The yoke slides vertically, and is held up by springs on screws attached to the side tubes of the lamp. On depressing the yoke the holder can be removed laterally from the slot. The yoke is strengthened by an under plate, perforated for vertical introduction of an upper carbon after the holder and globe have been removed. The lower carbon is clamped by a lateral screw in the holder. The cover plate is carried by insulators on sleeves, which slide on the side tubes, and are fixed by screws at a height to suit the globe. An outer globe is supported by a holder on a screw attached by a lower yoke to rods which slide in holes in the screws, and are held up by ordinary means. 11 claims.

21,665. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (R. Fleming.) Dated October 30th, 1899. The frame consists of two plates connected by side pieces and screwed on a non-magnetic tubular casting, which is made with a shoulder to hold a plate, radial arms to support grooved insulating rings, a horizontal part to carry the lamp terminals and a switch, and with supporting lugs at the top. Two plates are secured with intervening mica insulation to the bottom plate of the frame; one plate carries rods and a yoke. The upper part of the frame is enclosed by a fixed cylindrical casing, with cornices and the lower part by a vertically-sliding casing having an open cornice. In trimming, the lower casing is raised and turned so that projections on it rest in the upper casing. A white shade or reflector is secured by a clamping-ring on the lower casing. The arc-enclosing globe is held in a packed groove in the plate by a packed cap which is made of metal with an insulating coating, and is screwed on the lower carbon holder. The groove in the plate is preferably much deeper than the packing, to impede circulation of air if the globe ceases to fit tightly. Preferably no outer globe is used. The lower carbon holder is a radially split block, coned externally to fit an aperture in the yoke, so that, when drawn down by the cap, it grips the carbon. Screws project from it into slots in the yoke to prevent turning. The upper carbon passes through a circularly grooved boss on the plate, and is placed in a holder which slides in the regulating tube, and contains a spring carrying a projecting insulating button to press the body of the holder against the tube. Connection with the tube is made by a flexible conductor and slip. The tube carries a clutch, a dash-pot, and a tapered core within a solenoid. Rings support coiled wire resistances, part of which may be cut out by a clip consisting of two flat metal plates, which are held together by a bolt and nut, and made with a projection to prevent the nut from turning; single turns in two adjacent coils are clamped between these plates. 20 claims.

21,666. "Improvements in automatic cut-outs for rotary electrical converters and alternators." The British Thomson-Houston Company, Limited. (C. P. Steinmetz.) Dated October 30th, 1899. Relates to arrangements for cutting out rotary converters or other apparatus such as alternators, should the speed exceed predetermined limits, magnetic cut-outs being arranged in a tuned local circuit. In the arrangement described a converter and coils of magnetic cut-outs which are in the circuit of a battery when a switch is closed. The magnet controlling the switch arm is in a tuned circuit on the alternating-current side of the apparatus. The circuit includes a suitably-adjusted inductive resistance and condenser. On the speed of the apparatus exceeding the limit, the armature is attracted, so closing the local circuit through the cut-outs. 6 claims.

21,667. "Improvements in systems of electrical distribution and measurement." The British Thomson-Houston Company, Limited. (C. P. Steinmetz.) Dated October 30th, 1899. Electric lamps or other consuming apparatus are placed on separate constant and night supply wires, with a common return, and to induce consumers to remove most of their lamps, &c., from the constant supply wire a lower charge is made for energy supplied from the night wire, on which a supply is given during limited hours only. The system is especially applicable where supply is given from isolated alternating current transformers, the constant circuit being connected with a separate transformer which is made small to reduce the constant loss in it, and supplied from mains. The night circuit is connected with a transformer on mains, one main being connected with a generator during limited hours. Motors are supplied at higher pressure than the constant circuit, in order that the whole energy supplied may be registered at different rates by an ordinary meter, the field coils of which are in the common return, while the armature is supplied from the constant circuit. Current used on the night circuit is thus supplied at a higher pressure than that applied to the meter armature. Or both circuits may be at equal pressure, and the meter provided with separate field coils for the common return wire and the constant supply wire; the field coils may be provided with several terminals for connecting any desired number of turns in circuit. Such methods of measuring are claimed generally for any number of circuits. 33 claims.

21,668. "Improvements in alternating current meters." The British Thomson-Houston Company. (W. H. Pratt.) Dated October 30th, 1899. An induction motor meter is provided with a small electro-magnet in the pressure circuit, acting on the rotary part independently of the principle coils, and with an adjacent metal ring, which may be adjusted horizontally to neutralise any tendency of the rotary part to turn when no energy is being supplied, and to compensate for friction when the load is small. The electro-magnet is included in circuit with the coil and a large inductance between two mains; adjustment of the ring does not appreciably affect the constant of the meter. The coil is on a laminated core, which is also surrounded by a small closed circuit coil to cause the magnetic flux in it to be in exact quadrature with that in the main current coils, when the load is non-inductive. A permanent brake magnet is adjustably fixed by screws and a slot. The symmetrically placed coils may be in the principle mains of a three-wire single-phase system. The meter is also applicable to any symmetrically loaded system. 6 claims.

21,669. "Improvements in electric meters." The British Thomson-Houston Company, Limited. (E. Thomson.) Dated October 30th, 1899. A continuous current motor meter having no brake is arranged as shown. Stationary main current coils tend to turn a movable coil connected with additional resistance between the mains in opposition to a spring, and so that an arm of the coil touches a contact. This closes the primary circuit of a motor-generator between the mains. The armature is situated in a permanent magnetic field, and its speed increases until the proportional secondary current, which passes through stationary coils, balances the effect of the main current coils on the movable coil. The spring then opens the contact, and the speed of the motor-generator falls off until the effect of the main current again closes the contact. These operations continue, and the motor-generator thus runs at speeds varying about a mean proportional to the main current, if the pressure remains constant, or to the power supplied, and its revolutions are registered by a counter. 13 claims.

21,670. "Improvements in alternating electric current transformers." The British Thomson-Houston Company, Limited. (A. R. Everest.) Dated October 30th, 1899. Relates to transformers having relatively movable coils for maintaining a constant current or constant potential. In the arrangement one coil is fixed and another coil is suspended from one end of a lever which is supported on knife edges. On the other end of the lever is a grooved cam-piece to which a weight is attached. The cam is slotted, and is fixed in its desired position by a

engineer to the Corporation of Gravesend, is responsible for the preparation of this specification.

bolt. It is preferably arranged so that the weight of the coil opposing repulsion lessens as the distance apart of the coils increase. The transformer may be fitted in a casing filled with oil. 14 claims.

21,720. "Improvements in and relating to switches for electric light." T. Bell and S. S. Berry. Dated October 31st, 1899. Tumbler switch adapted for high voltages. The contact-lever is forked and is pivoted to the supporting bracket and its ends work in recesses in the base, which are separated by a bridge to prevent sparking. The bracket is fixed to a projecting part of the base. The fixed contacts are connected to the terminals, which are fixed in the recessed base by nuts. The porcelain handle is recessed to receive a projection on the cross-bar of the lever, and a spring gives the quick break. 1 claim.

21,742. "Improvements in electric railway rail bonds." T. J. McTighe. Dated October 31st. Date under International Convention, May 24th, 1899. Rail bonds with solid terminals and flattened bodies are slit and bent or opened out, and may be corrugated to give flexibility. A shoulder is left all round the heads and a countersink may be made in the heads to facilitate the spread of metal when they are inserted in the rails. The slit strips may be twisted to an angle with the plane of the body. The bond may be made by upsetting, shaping, flattening and slitting by dies or saws a length of wire or rod. 7 claims.

21,777. "Improvements in electric conducting sheaths or coverings for articles of ceramic or pulverulent materials." D. Szanka and Ganz & Co., Elsenglesserei und Maschinen-Fabriks, Actiengesellschaft. Dated October 31st, 1899. Conductive coatings for compressed powder or ceramic articles, such as electric resistances are produced by applying iron, nickel, or other metallic powders, or iron or other oxides, with a reducing-agent, such as carbon and a binding-material such as clay, gypsum, or isinglass, if necessary. The coating material may be applied in the form of plates or painted on, or pressed on in the powdered or plastic state, in such a way as to unite intimately with the articles, which are afterwards dried or fired. 2 claims.

21,778. "Improvements in electrically controlled elevators or lifts." H. Rowntree. Dated October 31st, 1899. Relates to electrically operated and controlled lifts in which (1) the cage being at rest at any landing it can be sent to any other landing by pressing a button at any one landing; (2) once started the motion of the cage cannot be arrested or reversed until it has arrived at the landing to which sent; (3) the cage slows down and stops automatically; and (4) the cage cannot be operated so long as a door at any one of the landings is open. This specification is too complicated for purposes of abridgment. 59 claims.

21,780. "Improvements in electric relays." H. H. Lake. (W. G. Nixon.) Dated October 31st, 1899. Relays for use with induction coils are arranged with the local circuit, including the sounder consisting of the line connected to the two relay armatures and either line. The relay armatures are polarised one by the primary circuit of the induction coil, and the other by the secondary. In modified forms the armature of the first is provided with two pairs of cross-connected contacts, and these may be either connected in the primary and secondary circuits or both in the primary circuits, the local circuit being connected to a second relay, the polarising-coil of which is connected to two of the first relay contacts. 6 claims.

21,807. "Improvements in electric massage instruments." L. Casgar and A. H. Pierce. Dated October 31st, 1899. Rollers are mounted on a spindle bearing in arms on a collar on a hollow neck of a case provided with a handle. A vibratory device, consisting of strikers preferably in pairs, is connected by a shank to an arm attached to an armature pivoted to a bracket. A spring on the armature normally makes contact with a screw on an insulated plate, and a spring keeps the armature out of contact with the pole-pieces of electro-magnets above. Wires from a battery pass down a channel in the handle, and are connected to the coils and to the plate, and when the circuit is closed the vibratory device vibrates. Clockwork or other mechanism may be used to actuate the vibratory device. Electricity is administered along with the rolling and tapping action by pressing a button, which completes, through a contact piece, a circuit comprising a wire for the plate and a wire leading to the arms, the remaining rollers, and the striking part, through connections with the armature and coils, serving as electrodes; or the rollers may be insulated and serve as the electrodes or strikers; or parts of a striker may be insulated to serve the same purpose. 3 claims.

21,810. "Improvements in electrical measuring instruments." H. P. Davis and F. Conrad. Dated October 31st, 1899. Date under International Convention, April 1st. Current meters for use as ampere or voltmeters. Two U-shaped permanent magnets, fixed parallel, with like poles together, carry two hook shaped pole-pieces, the curved parts of which are parallel and at a small distance apart. A single magnet may be used. A curved magnetic plate is adjustably fixed below the pole-pieces. The magnets carry a horizontal rectangular frame containing two jewelled pins which support the pivots of a light movable frame. This consists mainly of a bobbin preferably stamped from one piece of sheet aluminium, to enclose one of the pole-pieces along which it is movable. A flat plate balances the movable frame and passes between the pole-pieces to damp the movements magnetically. The ends of the coil wound on the bobbin are connected to the outer ends of two flat spiral springs carried by the pins, the outer ends of the springs are attached mechanically to arms of the movable frame, but insulated therefrom. A pointer attached to the movable frame indicates on a curved scale carried by the magnets. 3 claims.

21,877. "Improvements in or connected with electric arc lighting." A. Vosmaer. Dated November 1st, 1899. The electrodes are fixed at a few millimetres apart, one or both being made of nickel, or nickel alloy, and a small current used at high pressure, under which conditions the electrodes are stated to wear inappreciably, the end of the nickel electrode becoming coated with oxide from which the light is emitted. The second electrode may be of copper. With electrodes 3 mm. diameter, and an alternating current of ·1 ampere at 500 volts, 50 C.P. is obtained. Application to searchlight apparatus is mentioned. The provisional specification described an electrode consisting of a metal tube filled with refractory material, such as an alkaline earth or a rare earth. 2 claims.

21,881. "Improvements in electric incandescence lamps." H. H. Lake. Dated November 1st, 1899. Leading-in wires are made of alloys of iron and nickel, and may also contain other metals. A nickel-steel alloy with about 36 per cent. of nickel has a temperature expansion coefficient near y zero, and by adding a proper quantity of one metal, preferably nickel, the alloy can be made to have the same coefficient as any glass used for bulbs. The effect of other metals such as chromium or manganese in the alloy may be neutralised by diminishing the proportion of nickel if this is large, or increasing it if small. The wire is enclosed in thin glass, melted at the lowest possible temperature, so that the wire does not come in contact with the flame; this may be effected with a bulb provided with glass tubes to receive the wires. Or the leading-in wires may consist of short pieces of platinum brased or soldered between pieces of the nickel alloy wire. 2 claims.

21,996. "Improvements in and relating to the manufacture and repair of incandescent electric lamps." F. Fanta. Dated November 2nd, 1899. Filaments are flashed, after being mounted permanently in the bulbs, in a stream of a mixture of a hydro-carbon vapour with air, which prevents deposition of carbon on the bulb, a photometer being simultaneously applied and the electric pressure increased until the lamp gives the desired candle-power at a pressure somewhat above that to be applied normally. The mixture may contain 3 to 10 per cent. of air and be used under a pressure of from 4 to 15 mm., depending on the candle-power and resistance of the filaments, the size of the bulbs, and the power of the exhausting pump. The mixture may be made in a pump drawing air and vapour through separate regulating valves, and delivered through a gas holder, a heating coil, an automatic or other pressure regulating valve, a stop valve and a small tube held in packing and extending to the upper end of the lamp. The tube of the lamp is secured in packing and connected through a stop valve and a pressure regulating valve with the exhausting pump. Old lamps are repaired by unsealing the bulbs and attaching tubes. The bulbs are then heated externally while hot air or oxygenised air is passed through them, to burn off the deposit on the bulbs. The old filaments are then flashed in the manner above described to the desired candle-power, and the lamps are exhausted and sealed. 7 claims.